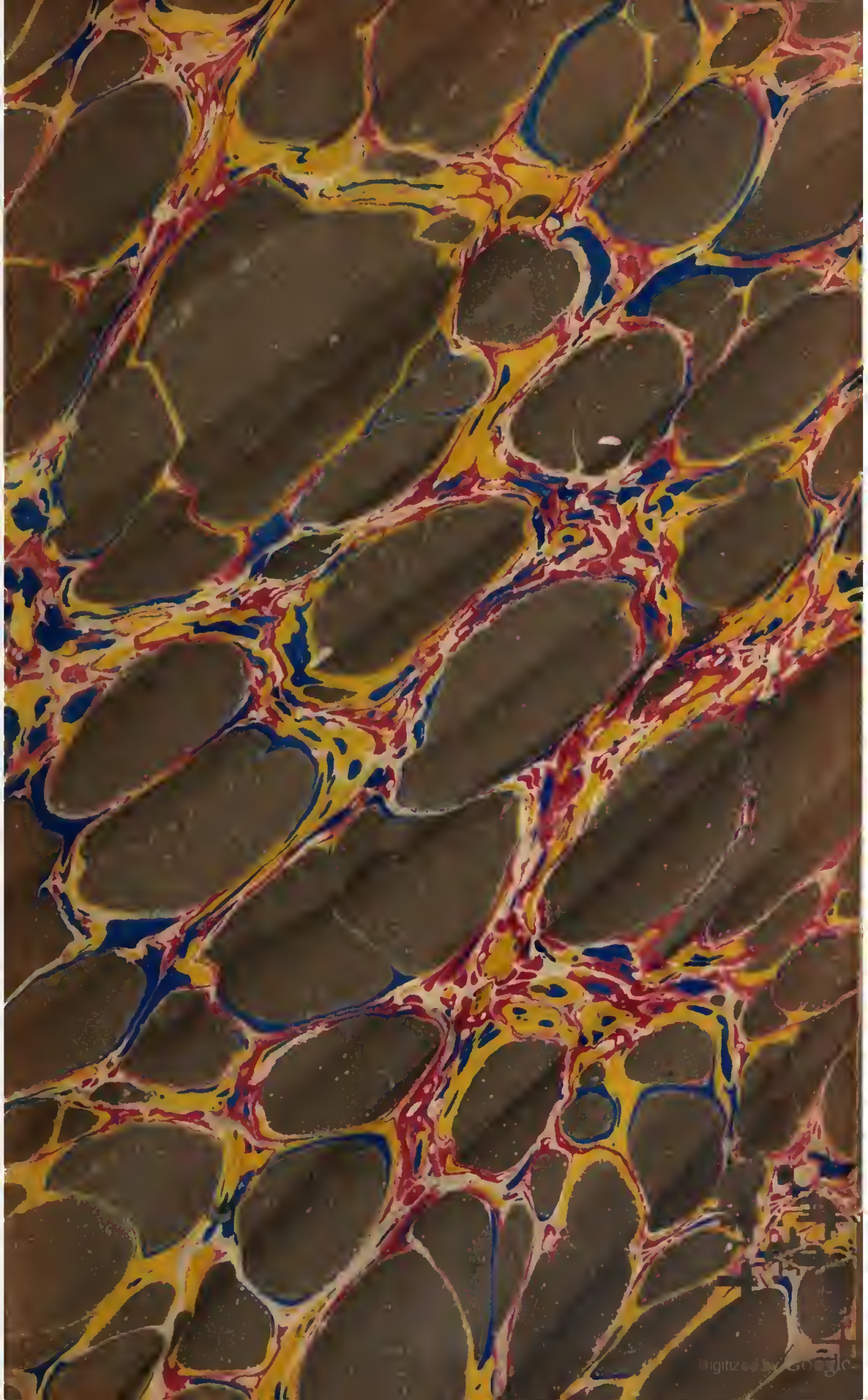


REMARKS

ON

THE COMPARATIVE MERITS

OF

CAST METAL AND MALLEABLE IRON

RAILWAYS;

AND

AN ACCOUNT

OF THE

STOCKTON AND DARLINGTON RAILWAY,

AND THE

LIVERPOOL AND MANCHESTER RAILWAY,

&c. &c.

BY MICHAEL LONGRIDGE.

NEWCASTLE:

PRINTED AT THE COURANT OFFICE, PILGRIM STREET,

BY J. BLACKWELL AND CO.

1838.

VIEW OF LOCOMOTIVE ENGINE MANUFACTORY, & BEDLINGTON IRON WORKS,
NEAR MORPETH.

INTRODUCTION.

WHEN laying before the public the following compilation of papers upon Railways, the editor would first present to the attention of his readers the important opinions of Dr. Arnott and of Dr. Lardner.

In Dr. Arnott's "*Elements of Natural Philosophy*," the treatise upon *Friction* leads him to a discussion of the invention of Railroads, which he conceives to be a species of machinery yet very far short of the perfection which they are likely to attain.

On the success of combining the Steam Engine with the Railroad he is sanguine, and dwells at great length upon the advantages to be derived from such an union.

He remarks:—"Without in reality changing the distance of places, it would have the effect of bringing all parts nearer to each other, and would give to the whole kingdom the convenience of both town and country. In any one part a man might consider himself as very near to any other part; for, at

the expense of as little time and money as he now spends to go a short distance, he might go a long one. The over-crowded and unhealthy parts of towns would immediately scatter their inhabitants to the country; for a man with such cheap and speedy conveyance at his command, would be as near his business, although living several miles off, as he now is in an adjoining street. A man living in the remote mountains might consider the ocean as only beyond the nearest hill; for he would only have to wish it, and he would be there. In like manner, the inhabitants of the coast, for a very small sacrifice, might visit the countries of the interior. The present heavy charges for bringing produce to market from great distances being thus nearly saved, the buyer everywhere would purchase cheaper, and the producer would still be better remunerated.—In a word, such a change would arise, as if the whole of Britain had been compressed by magic into a circle of a few miles in diameter, yet without any single part losing the least of its magnitude or beauties; and the sea would be but a little way south of the metropolis, and Edinburgh but a little way north, and the mountains of Wales but a little way to the west. This appears visionary, but it is less so than it would have been, 70 years ago, to anticipate what has now come to pass, that the common time of travelling from London to Edinburgh would be 46 hours. At the opening of the Railroad near Darlington, last year, a train of loaded carriages was dragged along by one little Steam-Engine, a distance of 23 miles, and in some parts of the journey the speed was more than 20 miles an hour. The whole load was nearly equal to a regiment of soldiers, and the coal expended was under the value of a crown. An island with such roads would be an impregnable fortress; for, in less time than an enemy would require to disembark on any part of the coast, the forces of the country might be concentrated to defend it."

Subsequent experience has enabled Dr. Lardner to express himself in the following decisive language:—

"I have made some experimental trips, in which more limited loads were placed upon the engines, by which I have ascertained that very considerably increased rates of motion are quite practicable. In one experiment I placed a carriage containing thirty-six persons upon an engine, with which I succeeded in obtaining the velocity of about forty-eight miles an hour, and I believe that an engine loaded only with its own tender has moved over fifteen miles in fifteen minutes. Full trains of passengers, commonly transported upon the Manchester railroad, weigh about fifty tons gross: with a lighter load, a lighter and more expeditious engine might be used. The expense of transport with such an engine would of course be increased; but for this the increased expedition there would be ample compensaton. When, therefore, London shall have been connected with Liverpool, by a line of railroad through Birmingham, the commercial interests of these places will naturally direct attention to the greatest possible expedition of intercommunication. For the transmission of mails, doubtless, peculiar engines will be built, adapted to lighter loads and greater speed. With such engines, the mails, with a limited number of passengers, will be despatched; and, apart from any possible improvement which the engines may hereafter receive, and looking only at their present capabilities, I CANNOT HESITATE TO EXPRESS MY CONVICTION THAT SUCH A LOAD MAY BE TRANSPORTED AT THE RATE OF ABOVE SIXTY MILES AN HOUR. If we may indulge in expectations of what the probable improvements of locomotive steam engines may effect, I do not think that even double that speed is beyond the limits of mechanical probability. ON THE COMPLETION OF THE LINE OF ROAD FROM THE METROPOLIS TO LIVERPOOL WE MAY THEREFORE EXPECT TO WITNESS THE TRANSPORT OF MAILS AND PASSENGERS IN THE SHORT SPACE OF THREE

HOURS. THERE WILL PROBABLY BE ABOUT THREE POSTS A DAY BETWEEN THESE AND INTERMEDIATE PLACES. The great extension which the application of steam to the purpose of inland transport is about to receive from the numerous railroads which are already in progress, and from a still greater number of others which are hourly projected, impart to these subjects of inquiry considerable interest. Neither the wisdom of the philosopher, nor the skill of the statistician, nor the foresight of the statesman, is sufficient to determine the important consequences by which the realization of these schemes must affect the progress of the human race. How much the spread of civilization, the diffusion of knowledge, the cultivation of taste, and the refinement of habits and manners, depend upon the easy and rapid intermixture of the constituent elements of society, it is needless to point out. Whilst population exists in detached and independent masses, incapable of transfusion amongst each other, their dormant affinities are never called into action, and the most precious qualities of each are never imparted to the other. Like solids in physics, they are slow to form combinations; but when the quality of fluidity has been imparted to them, when their constituent atoms are loosened by fusion, and the particles of each flow freely through and among those of the other, then the affinities are awakened, new combinations are formed, a mutual interchange of qualities takes places, and compounds of value far exceeding those of the original elements are produced. Extreme facility of intercourse is the fluidity and fusion of the social masses, from whence such an activity of the affinities results, and from whence such an inestimable interchange of precious qualities must follow. We have accordingly observed, that the advancement in civilization, and the promotion of intercourse between distant masses of people, have ever gone on with contemporaneous progress, each appearing occasionally to be the cause or the consequence of the other.—Hence it is that the urban population is ever in advance of the

rural in its intellectual character. But, without sacrificing the peculiar advantages of either, the benefits of intercourse may be extended to both, hy the extraordinary facilities which must be the consequence of the locomotive projects now in progress. By the great line of railroad which is in progress from London to Birmingham, the time and expense of passing between those places will prohahly be halved, and the quantity of intercourse at least quadrupled, if we consider only the direct transit between the terminal points of the line; hut if the innumerable tributary streams which will flow from every adjacent point be considered, we have no analogies on which to build a calculation of the enormous increase of intercommunication which must ensue. Perishable vegetahle productions neeessary for the wants of towns must at present be raised in their immediate suhurbs; these, however, where they can be transported with a perfectly smooth motion at the rate of twenty miles an hour, will be supplied by the agricultural lahourer of more distant points. The population engaged in towns, no longer limited to their narrow streets, and piled story over story in confined hahitations, will he free to reside at distances which would now place them far heyond reach of their daily occupations. The saluhrity of cities and towns will thus be increased, by spreading the population over a larger extent of surface, without incurring the inconvenience of distance. Thus the advantages of the country will be conferred upon the town, and the refinement and civilization of the town will spread their benefits among the rural population."

Bedlington Iron Works,
January, 1836.

REMARKS.

THE plan of *Cast Iron* Railways is said to have been introduced into England about the year 1786, as an improvement upon the Tram or *Wooden* Railway.* The Rails were then made flat, or about four inches in breadth, with a projecting ridge or flange upon the outer verge.

Of late years this form has been almost entirely superseded among the principal Collieries in the North of England, by the introduction of the *Edge-Rail*, which consists of a Bar of Cast Metal, of from three to four feet in length, 2½ inches at the top for the *seat* of the Wheel, and from 5 to 7 inches deep, according to the weight to be carried.

From recent experiments, it has been ascertained, that upon an Edge Railway one Horse can work with a much greater load (in the proportion of 10 to 7) than upon a Tramway. These experiments were made upon a Tramway, which was kept clean for the occasion. Mr. Robert Stevenson says, in the report just referred to, (pages 24 and 25,) "The Reporter is led from his own "observation, and the opinion of the following profes- "sional gentlemen obligingly communicated to him, viz. "Mr. Wilson, of Troon; Mr. Bald, of Alloa; Mr.

* Stevenson's Report on the Edinburgh Railway, dated 28th December, 1818, page 7.

" Landale, of Charlestown; Mr. Grieve, of Sheriff Hall;
" and Mr. Buddle, of Newcastle, who are not only scien-
" tifically but practically conversant in this matter, to
" conclude that the *Plate Rail not only induces greater*
"*friction, but is more exposed to have the Wheels clogged*
" *and interrupted with gravel or small stones.*"

Cast Iron in the fluid state being capable of being moulded into almost any shape or figure, the Engineer is thereby enabled, in the construction of the Rail, not only to present a sufficient breadth of surface for the Wheel to travel upon, but also so to dispose of the remaining portion of the Metal as to produce that particular form which he conceives to be best adapted for sustaining the weight to be borne upon it.

Hence, *Cast Iron* has been so generally made use of for Railways.

But on the other hand it must be recollected, that there is a constant and considerable expense incurred in supplying the loss occasioned by broken Rails, owing to the brittleness of the material; unless, indeed, the Rail be made of sufficient strength to resist without injury the effect of blows or shocks, to which it is unavoidably exposed, and which would require it to be of six times the weight otherwise necessary.

My attention was first drawn to the subject of substituting *Malleable* for *Cast* Iron Rails, by reading the Report of Mr. Stevenson, on the Edinburgh Railway.

At page 26 of that Report, the Author remarks, " One
" point, however, deserves particular notice here, as like-
" ly to be attended with the most important advantages
" to the Railway system, which is the application of
" Malleable Iron instead of Cast Iron Rails."

" Three miles and a half of this description of Rail-
" way have been in use, for about eight years on Lord

"Carlisle's Works, at Tindal Fell, in Cumberland, where "there are also two miles of Cast Iron Rail; but the "Malleable Iron Road is found to answer the purpose in "every respect better."

"Experiments with Malleable Iron Rails have also "been made at Mr. Taylor's Works, at Ayr, and Sir "John Hope's, at Pinkie; and, upon the whole, this "method, as in the case of the Tindal Fell Railway, is "not only considerably cheaper in the first cost than the "Cast Iron Railway, but is also much less liable to "accident."

"In the use of Malleable Iron Bars, the joints of the "Railway are conveniently obtained, about 12 feet apart, "and three Pedestals are generally placed between each "pair of joints."

The Agent at the Earl of Carlisle's Colliery, at Tindal Fell, was requested to inform me what was the cost of the Iron Rails used there, and also to communicate any observations which he might have made upon the two kinds of Rails, with regard to economy in their use or otherwise.

In a letter received from him in the month of May, 1819, he says, "Our Rails are 1½ inches square, and "stand upon stones about 10 inches square, and are "placed at one yard distance from centre hole to centre "hole. Our Railway carries four tons weight, and has "never cost us any thing yet, as to the expense of the "Malleable Iron, except creasing.

"*The Iron I cannot see the least alteration with, al-*"*though it has now been laid eight years.* The Cast Iron "is a daily expense: it is breaking every day."

This account was received in the month of May, 1819; and in September, 1820, two professional gentlemen from Newcastle accompanied me to Tindal Fell Colliery to

inspect the Railway, and their Report fully confirmed the preceding statement.

The chief objection urged against Rails made of Malleable Iron is, that they are more subject to waste, by *rust or oxydation*, than Metal Rails; but the result of eight years trial, at Tindal Fell Colliery, proves most clearly the fallacy of this supposition.

The form of the Malleable Iron Rail hitherto in use, (which has universally been a Parallelopipedon,) is liable to two objections,—either that the narrowness of the surface, when compared to the breadth of the rim of the Carriage Wheel, is so considerable as to expose both the Wheel and the Rail to great injury from wear; or, if the breadth be so increased as to remove this objection, this is only effected by introducing a second one in its place, arising from the necessity of increasing the weight of the Rail, (the strength being as the breadth and square of the depth,) which would then make the cost amount almost to a prohibition of its use.

It was to obviate these objections that the Iron Rail, the subject of the annexed Specification, was contrived, which, while it presents the same extent of surface to the Wheel as the Cast Iron Rail does, saves the expense occasioned by the breaking of the Metal Rails; and from its form, admits of being made so light as to render *the first cost of a Malleable Iron Railway less than that of a Cast Iron Railway of equal strength.*

The advantages derived from this method of constructing Railway bars may be summed up as follows:—

1st. The original cost of a Malleable Iron Railway is less than that of a Cast Iron Railway of equal strength.

2ndly. As the Rails can be made in lengths of 9, 12, 15, or 18 feet each, and even longer when required, the number of joints is thereby reduced; and thus is removed,

in a great measure, the liability to which the short Rails now in use are exposed, of receiving blows and shocks from the Carriages which move over them.

3rdly. In order to remedy the evil arising from the Rails being imperfectly joined, the plan of *welding* the ends of the Rails together has been adopted; by this means, making one continued Rail the whole length of the road without any joint whatever.

4thly. It hence follows, that on the Iron Railways, the loss of Coals, occasioned by the jolting of the Waggons at the joints of the Rails, and the injury done to the Wheels, the Carriages, and Engines, from the same cause, are, if not entirely prevented, at least considerably diminished.

When I first proposed the use of Malleable Iron instead of Cast Iron, for Railway Bars, a variety of objections were urged against the change.

Amongst many others the following reasons were given to the Directors of the Stockton and Darlington Railway, who were at that time about to contract for a supply of Railway Bars.

Extracts from Letters to the Directors of the Stockton and Darlington Railway, relative to Malleable Iron Railway Bars.

FROM E. FRERE, OF CLYDACH.

June, 1821.

"Were I to make a road *de novo*, and still more if I were to make a long public road for serving an extent of country with coal, lime, &c., I should prefer the Railway on principles something like those of Losh and Stephenson's Patent. As to Malleable Iron, those who recommend it have something different in view to what I have met with—*I should not expect much from the plan as to price, durability, or strength.* Cast Iron is cheaper weight for weight, and stronger bulk for bulk; those who see the effect of a blow on each may think this untrue, but a slighter strain than is sufficient to break a cast bar will permanently bend one of Malleable Iron, and a repetition of the same force which gives a bar of iron a bend will break it—its being bent, even, will spoil it as a rail."

FROM WILLIAM JESSOP.

"Butterley Iron Works, June, 1821.

"I am acquainted with most of the public Railways in this kingdom, several of which have been contracted for and executed by the Butterley Company. I have also seen Malleable Iron used on Railways, but *I should by no means recommend their adoption for public Railways.*

"From my own experience, I find the edge Railway has many advantages over the flange Railways; greater strength is obtained in the application of the Iron, and less liability to fracture.

"The surface of the Rail is not so much exposed to dirt, and in winter, to snow and ice, which are obstructions to the Flange Rails; and there is considerably less friction, and of course a horse can draw greater weight.

"I have read Mr. Birkinshaw's specification of his Patent Malleable Iron Railway, as well as his observations, but I differ from him in his conclusions.

"He has given a very unfair statement in his comparison of the two kinds, which is not the result of experience, but to favour his interest in the Patent.

"The blocks or supports on which both kinds of rails rest, are equally liable to be displaced, as it is impracticable to lay a Railway that shall retain its original position; —the ground will sink, particularly on embankments; and then the injury to a long Malleable Iron Rail having many supports would be certain, whereas the joinings of the cast Iron Rail at every support would admit the irregularity that is certain to occur by the partial settlement and displacement of the blocks. The long rails would also be subject to undue strains for want of uniform support, and for want of the joinings, the blocks could not so readily be taken up to raise and replace with accuracy. If Cast Iron Rails were made in great lengths, and having more supports than at the ends, their destruction would be immediate, and this is avoided in the Malleable Rails from the ductility of the Iron; *but the frequent straining and creasing of the Iron must soon render such a Railway very imperfect.*

"I cannot admit that Wrought Iron would be cheaper than Cast Iron, neither is the breakage of Cast Iron,

when of proper strength and construction, a thing of much consideration, *indeed I think it would not exceed the expense of keeping the Malleable Rails on his construction, in an accurate and true state.*

"If I were to use Wrought Iron Rails, *I certainly would lay them down in short lengths,* for the passing of the joinings with high wheels is scarcely perceived, and of *no practical consequence.*"

Notwithstanding this opposition, the Directors resolved upon using the Malleable Iron Railway Bars.

I have also the pleasure of saying, that the Patent Malleable Iron Railway Bars have been used for some time past in the extensive Lead Mines of T. R. Beaumont, Esq., the Governor and Co., and Thomas Hopper, Esq.; and also upon the Stockton and Darlington, the Liverpool and Manchester, the Bolton, the Canterbury, the Monkland, the Ballochney, and the other public Railways in Great Britain, which have been formed since the introduction of the Patent Malleable Iron Railway Bars; and at several of the principal Collieries upon the Tyne and Wear,—from all of which places I have received the most favourable reports of the Rails.

I have much gratification in being enabled to add the following extracts from the Supplement to the Encyclopædia Britannica (Article, Railways,) published in 1824, and from an account recently published of "Railways in Lanarkshire."

"Since Edge Railways have come into more general use, an essential improvement has been made in their construction, by the use of Malleable Iron, in place of Cast Iron, in forming the Rails. The advantage of Malleable Iron Rails is, that they are less subject to breakage than Cast Iron; a circumstance of importance in this case, where it is not easy to avoid those jolts and sudden

shocks which Cast Iron is least of all capable of withstanding, and though they should happen to give way, they are easily repaired. They can also be laid in greater lengths, and require, therefore, fewer joints; they can be bent, with ease, to the curvature of the road; when worn out, they are of greater value; and, lastly, their first cost is very little, if at all, greater than Cast Iron Rails. Malleable Iron is, no doubt, less able to withstand exposure, decaying more readily under the influence of air and moisture; but, hitherto, this inconvenience has not been felt, and, on the whole, the Malleable Iron is now decidedly preferred. These Rails are laid and jointed in the same manner as the Cast Iron, only in greater lengths. Malleable Iron was first introduced in Railways, we believe, by Mr. George Grieve, at Sir John Hope's Collieries, near Edinburgh, where it was first tried in the lighter work, which is done under ground. The Rails consisted of square bars, one inch and one and a quarter inch square, nine feet long, resting on one or two sleepers in the middle, and resting and made fast to sleepers at the extremities; a simple knee being formed on each end of the bar, and the two knees of each two adjacent Rails jammed into one socket in the sleeper. The use of these Rails was found so beneficial, that they have since entirely superseded the Flat Cast Iron Rail in general use at the time of their invention. For heavier roads, the Rails are made deeper. We have been favoured with the following account of their construction, by an engineer (Mr. Neilson, of Glasgow,) who has formed several of the kind:

"'One of them is on the property of the Earl of Glasgow, commencing at the Hurlet extensive Coal and Lime Works, and extending to the Paisley Canal, a distance of about two miles. It is formed of flat bar iron, two and a quarter inches deep, by nearly three quarters

of an inch thick, and the Rail in lengths of nine feet, each Rail being supported at every three feet by a sleeper and Cast Iron chair. The jointings are formed by a Cast Iron dove-tailed socket, suited to receive the jointed ends of the bar, and a dove-tailed glut or key. By which means the several roads are joined as if into one continued Bar.'

"An improvement has lately been made in the construction of the Malleable Iron Rails, which promises to be of essential utility. It consists of the use of Bars, not rectangular, but of a wedge form, or swelled out on the upper edge. In the rectangular bar, there is evidently a waste of Metal on the under surface, which not requiring to be of the same thickness as where the waggon wheel is to roll, may be evidently reduced with advantage, if it can be done easily. The bar may then be made deeper and broader at the top than before, so as with the same quantity of Metal to be equally strong, and present a much broader bearing surface for the wheel. This has been accomplished by Mr. Birkinshaw, of the Bedlington Iron Works, who has obtained a patent for those broad-topped Rails. The peculiar shape is given them in the rolling of the Metal, by means of grooves cut in the rollers, corresponding with the requisite breadth, and depth, and curvature of the proposed Rail. Mr. B. recommends his Rails to be eighteen feet in length. We have seen one of these Patent Rails at Sir John Hope's Colliery; and it certainly forms the most perfect Iron Rail which has hitherto been contrived: combining very simply and ingeniously in its form, qualities of lightness, strength, and durability.

"It is twelve feet long, two inches broad along the top, and about half an inch along the bottom, and still thinner between. It rests on sleepers at every three feet, and at those places the Rail is two inches deep, while in the middle point, between the sleepers, it is three inches deep.

All these inequalities, we believe, are performed on the Metal, by means of the rollers; and this circumstance is well deserving of attention, as it may obviously be applied not only to the formation of Railways, but to a variety of other arts. The moulding and shaping of metal in this way is quite a new attempt in the iron manufacture, and it is not easy to say how far such an invention may yet be carried by the skill of British Artists."

Extract from an "Account of the Lanarkshire Railways," by G. Buchanan, Esq.

The rails all along the line, are of the size of twenty-eight pounds to the yard of single rail; but over Robroyston Moss they are stronger, being thirty-six pounds to the yard. They are all, on this as well as on the Ballochney, Wishaw and Coltness, and Monkland and Kirkintilloch Railways, of the malleable iron patent rails, from Bedlington Iron Works, which have here fully sustained the character they have acquired in other places. The introduction of these rails is without doubt one of the greatest improvements which have occurred in the construction of Railways, since the grand step of the conversion from wood to metal; this secured and established a similar conversion from cast iron to malleable iron, a change equally important, and which had already begun to take place, but could never have been so generally and universally adopted, had it not been for the ingenious contrivance introduced by the Bedlington Iron Company, of moulding and shaping the malleable iron into the form which had hitherto been found most convenient for Rail-

ways in cast iron. Among the many advantages of the wrought iron, not the least is its safety; its introduction, therefore, forms a very important concurring circumstance in the success of the Locomotive Engine. With cast iron, there was always a risk of fracture under the great loads of the Locomotive Engines and the violent concussions inseparable at times from their action. The introduction of a safer material, therefore, has without doubt accelerated that completion of the plan of Railways, the introduction of the power of steam; without which it would have continued as a mere appendage to coal mines, instead of becoming a great medium of inland trade. In the appendix, at the end of this article, will be found a letter just received from Mr. Longridge, the intelligent and enterprising manager of the Bedlington Iron Works, explaining the history of the introduction of the patent railway bars. The important improvement of joining the rails together, by half lapping their extremities over each other, in the manner of the cast iron rails, was introduced at the suggestion of James Jardine, Esq., Civil Engineer. The rails rest on cast iron chairs of the usual form, bedded in the stone, and their extremities are united by half-lap joints.

Bedlington Iron Works, Jan. 16th, 1832.

My Dear Sir,

I cannot better reply to your letter of the 12th instant, than by giving you a short account of the reasons which induced me to attempt the substitution of *wrought iron* in the place of *cast* iron Railway bars.

In the year 1818, an offer was made to me for supplying these works with coals at a reduced price, provided the Bedlington Iron Company would lay a Railway from

the colliery. In the course of my enquiries as to the cost of this Railway, the report of a proposed Railway "from the coal-field of Mid Lothian, to the city of Edinburgh, by Robert Stevenson, Esq.," was put into my hands; Mr. Stevenson's remarks in favour of the malleable iron rails, (page 26 of the report) attracted my attention. I ascertained that malleable iron rails had been tried at Wylam Colliery, near Newcastle upon Tyne, as well as at Tindal Fell, in Cumberland; the former were bars about 2 inches broad, and ¾ of an inch thick, which were placed *edge-ways*. They were found so injurious to the waggon wheels, as to oblige the proprietors of the colliery to remove them. The Railway bars at Tindal Fell, were bars one and a half inches square; the objections against them were chiefly; 1st, that the surface upon which the wheels ran was too narrow, and 2ndly, that the depth of the rail could not be increased without adding so much to its weight, and consequently to its cost, as to prevent malleable iron rails being generally used.

Notwithstanding these and other less important objections, I was so convinced of the superiority of malleable iron over cast iron, as *the material* of which a Railway bar ought to be made, that I resolved upon laying down malleable iron Railway bars upon the road which the Bedlington Iron Company intended to make. Mr. John Birkinshaw, the principal Agent at these works, suggested the idea of making these Railway bars "*wedge-form*,"* by which means, the same extent of surface as the cast iron rail was preserved for the wheels to travel upon, and the depth of the bar increased without adding unnecessarily to its weight. By the recommendation of John

* In consequence of this suggestion, I took out a Patent for an IMPROVEMENT *in the Construction of Malleable Iron Rails*, in Mr. Birkinshaw's name: a copy of the Specification of this Patent is given at page 30.

Buddle, Esq., we afterwards made the rails with a swell or curvature in the middle. Several minor improvements have since been made, and I send you herewith a drawing of a rail, which we are now making for the Stockton and Darlington Railway: you will observe that the bars are fastened to the chairs or pedestals by iron wedges instead of nails, which has been found to be a considerable improvement.

Before concluding this letter, it is a duty which I have much pleasure in performing to acknowledge the great assistance which has been afforded to me by George Stephenson, Esq., the Engineer of the Liverpool and Manchester Railway, in introducing malleable Iron Railway bars. The Stockton and Darlington Railway Company were the first public company who adopted the use of malleable Iron Railway bars, and this they did after a deliberate examination of the arguments which were urged both in their favour and against them; and with the advice of Mr. Stephenson, who was then their Engineer, and who, although *interested* in favour of cast iron, (being a joint-patentee of the best cast-iron Railway bars then in use,) yet had the candour to recommend the others as superior.

Believe me, my dear Sir,

Very truly your's,

MICHAEL LONGRIDGE.

George Buchanan, Esq.,
Civil Engineer, Edinburgh.

In the year 1824, an attempt was made to excite doubt as to the durability of Malleable Iron Railway Bars, which occasioned the following Correspondence; and I am now enabled to add, that the Hetton Coal Company have, since the publication of this Correspondence, made use of considerable quantities of the malleable iron Rails, giving the most convincing proof that they have no apprehensions of the injury to be sustained by the "EXFOLIATIONS OR LAMINATIONS."

Bedlington Iron Works, November 23, 1824.

TO WILLIAM CHAPMAN, ESQ.

SIR,—In your Report on the Cost and separate Advantages of a Ship Canal and of a Railway from Newcastle to Carlisle, you state, "The Railway may either be formed of Cast Iron or Malleable Iron; the latter may be somewhat less expensive, and has been found eligible in Rolleyways below ground, in which the weight on each wheel is not considerable; but above ground, with heavy waggons, their utility, or rather their duration, is not likely to be so great as Rails of Cast Iron of due strength, because with heavy carriages and case-hardened wheels, (which are much in use except for Locomotives, as it would diminish their adhesion to the Way,) the following effect is produced from the softness of Malleable Iron, and the Rails formed of it being drawn out between Rollers, *and consequently fibrous*, viz. the great weight on these wheels, rolling on those Ways, expands their upper

surface, and at length causes it to separate in thin Laminæ. The injury from Oxydation is comparatively small."

I take the liberty, Sir, of enquiring upon what Railways this effect *is produced?*

I have this day examined the ONLY TWO Railways, where my Patent Malleable Iron Rails have been travelled over by the Locomotive Engines, dragging loaded Coal-waggons, and I do publicly assert that no such effect as you describe has taken place.

The Rails at Killingworth Colliery were laid in the year 1820, and have since been constantly used: those at Heaton Colliery were laid in the year 1821, and have also been travelled over by the Locomotive Engine used there; and I repeat, without the fear of contradiction, that *no such Lamination as you describe can be discovered.*

The Rails are still in use, and any one feeling an interest in the question, may easily satisfy himself by a personal inspection.

I wait a public reply to this letter, before adding any further remarks upon that part of your report which is quoted above.

I am, SIR, your obedient Servant,

JOHN BIRKINSHAW.

TO THE EDITOR OF THE NEWCASTLE COURANT.

Newcastle, November 30, 1824.

SIR,—As Mr. Birkinshaw, from being Patentee of the Malleable Iron Waggon-way Rails, is entitled to the information he has required from me in your last week's

paper, I feel it necessary to request your giving publicity to the following observations, viz.:—

Rolled Iron, after remaining some time in diluted Muriatic Acid, will form itself into a bundle of parallel fibres; and from being oxygenated through exposure to air and water, it will separate in thin Laminæ, as every person of moderate attention to facts must have seen, from the Exfoliations from the surface of iron hoops to water casks, when not protected by paint or other external coating. Why Mr. Birkinshaw should expect his Rolled Iron Rails to be exempt from this law of nature, remains for him to assign the cause. The fact is, that the constant passage of Coal Waggons upon them prevents the formation of Red Oxide; but the Black Oxide (which is in a more metallic state) rises in Laminæ, and is subsequently either raised by adhesion to the Waggon Wheels, or crushed to powder by their repeated pressure. The superficial expansion occasioned by the successive Rolling of heavy-laden Case-hardened Iron Wheels, necessarily causes a more ready admission of Oxygen, and the subsequent Exfoliations described.

As Mr. Birkinshaw has publicly asserted that, on his examination of the Waggon-ways of Killingworth and Heaton on the 22nd inst., no such Lamination as I had described had taken place, which *he repeats without fear of contradiction*, I, in consequence, requested a person, of great experience in Iron of every description, to take the trouble of examining, yesterday, the Rolled Iron Rails of Heaton and Killingworth Collieries, and to bring me a specimen of the Exfoliations. He found it unnecessary to go further than Heaton Waggon-way; from which, at a little distance from the Shields Turnpike Road, on the small portion of Rolled Iron Way they have formed, he brought me the specimen which I present to you, and

request the favour of you to keep for the conviction of Mr. Birkinshaw or his Partners,—which I am rather surprised they should publicly request, as it could scarcely fail to be known to them that the Exfoliation of their Rails on Nesham Main Waggon-way was the cause of their not being adopted on a recently-formed Railway of great extent to the River Wear.

Having thus vindicated the disputed assertion in my Report, I shall decline entering into any further discussion on the merits or demerits of these Rails,—and

I am, SIR, your humble servant,

WILLIAM CHAPMAN.

TO THE EDITOR OF THE NEWCASTLE COURANT.

Bedlington Iron Works, 4th Dec., 1824.

SIR,—I have to thank Mr. Chapman for his early reply to my letter of the 22nd of November.

As I make no pretensions to chemical knowledge, I must be excused from controverting any theory raised thereon, and content myself with a reference to facts.

I again repeat that no such "LAMINATION" as described by Mr. Chapman, in his Report on the proposed Carlisle Railway, has taken place in my Patent Malleable Iron Rails; and although I have seen the "*Specimens*" left with you, I do, with as much confidence as ever, request an INSPECTION of the RAILS THEMSELVES.

I am at a loss to conceive any reason for Mr. Chapman's troubling you with these particles of iron, or coal dust, or whatever else they may be called.

To put Mr. Chapman right, as to the cause why the

Malleable Iron Rails were not adopted at the Hetton Railway, I annex the copy of a letter from Arthur Mowbray, Esq., to the Manager of these Works.

The Bedlington Iron Company were willing to *warrant the Rails*, but refused to *uphold the Way, and therefore did not receive the Order for the Rails.*

As Mr. Longridge was prevented by ill health from meeting the Owners of the Colliery, at Mr. Scruton's office, in Durham, when the negociation was broken off, I attended for him, and do publicly assert, that the sole reason assigned (by Messrs. Scruton, Mowbray, Cochrane, and Dunn, the owners then present,) why the order was not given to the Bedlington Iron Company, was, the refusal to *uphold the Way*, as well as warrant the Rails for three years; and further, I assert, that not a word was said as to the Exfoliation of the Rails on the Nesham Main Waggon-way.

The subject is now before the public, and I willingly close this controversy, leaving the merits of my Patent Malleable Iron Rails to the test of experience.

I am, Sir, your obedient servant,

JOHN BIRKINSHAW.

COPY OF ARTHUR MOWBRAY, ESQ.'S, LETTER.

Houghton-le-Spring, 6th Nov., 1821.

Dear Sir,—The Hetton Company, to-day, have reconsidered the terms you have proposed to furnish them with Malleable Iron Rails upon.

To allow you to deliberate, they have resolved, after the Way is put into a proper state and condition, that

your Company uphold the same for three years, and that they expect your Company to warrant the Rails at the end of the said three years, to weigh a proper weight, allowing for wear.

I will be much obliged if you will favour me with a meeting at Dodsworth's, in Newcastle, at eleven o'clock on Friday next, to endeavour to close this business.

I am, DEAR SIR, your very obedient Servant,

ARTHUR MOWBRAY.

To Michael Longridge, Esq., Bedlington Iron Works.

TO THE EDITOR OF THE NEWCASTLE COURANT.

Bedlington Iron Works, 10th Dec., 1824.

SIR,—It was not my intention to have addressed you again on the subject of Malleable Iron Railways, after my letter of the 4th inst., but I am induced, by the receipt of a Letter from the Colliery Agent of the Earl of Carlisle, (a copy of which is subjoined,) once more to trespass on your readers' patience.

This letter appears to me to set at rest the dispute betwixt Mr. Chapman and myself, and to prove, from the experience of sixteen years, that Mr. Chapman's apprehensions of "Laminations," or "Exfoliations," are *entirely groundless.*

I shall take the liberty of leaving with you, for the inspection of Mr. Chapman, or any other persons, the piece of Rail which has been so obligingly forwarded to me by Mr. James Thompson, a gentleman who is totally disinterested in the question, and who, therefore, cannot be

suspected of being influenced by that partiality which may naturally be supposed to bias the opinion of

Your obedient servant,

JOHN BIRKINSHAW.

COPY OF MR. JAMES THOMPSON'S LETTER.

Mr. John Birkinshaw,—Sir,—Having read in the Newcastle Courant, the discussion between you and Wm. Chapman, Esq., respecting the Lamination of Malleable Iron Rails used for Railroads, and having under my care a Railway, whereon several miles both of Cast and Wrought Iron Rails are used, I have sent you herewith a piece of the latter, *which has been laid sixteen years, and certainly has no appearance of Lamination.*

This Rail was taken up by the same person who laid it down sixteen years ago, and who has ever since been employed upon this Railroad.

The whole of the *Wrought Iron*, which has been used from twelve to sixteen years, appears to be very little worse; the *Cast Iron* is certainly much worse, and subject to considerable breakage, although the Rails are about double the weight of the Malleable Iron Rails.

The Coal-waggons used upon this Road carry nearly a Newcastle chaldron of coals; a considerable quantity of lime is also conveyed along this Railway, and the laden Waggons are much heavier than those laden with coals.

I am, Sir, your's respectfully,

(Signed) JAMES THOMPSON.

Tindal Fell Colliery, Dec. 7th, 1824.

P. S. The piece of Rail sent herewith was taken from a turn on the Railway, apparently of about the angle of 45°, and has certainly been exposed to more wear than Rails upon a straight line.

Specification of the Patent

Granted to John Birkinshaw, of Bedlington Iron Works, in the County of Durham, for an IMPROVEMENT *in the* CONSTRUCTION *of* MALLEABLE IRON RAILS, *to be used in Railroads, whereby the Cost is reduced, and the Expense of Repairs of broken Rails saved.*

Dated 2nd December, 1820, *with a Plate.*

To all to whom these presents shall come, &c. Now know ye, that in compliance with the said proviso, I, the said John Birkinshaw, do hereby declare, that the nature of my said invention, and the manner in which the same is to be performed, are particularly described and ascertained in and by the drawings hereunto annexed, and the following description thereof, (that is to say,) my Invention consists in the adaptation of Wrought or Malleable Iron Bars or Rails of a peculiar form, instead of Cast Iron Rails as heretofore. From the brittle nature of Cast Iron, it has been found, by experience, necessary to make the bars of a Railroad sufficiently strong to bear at least six times the weight intended to be carried along the Road, by which the original cost of a Railroad was considerably augmented; or, if light Rails were used, the necessity of frequently repairing entailed a heavy expense upon the proprietors. To obviate these objections, I have

invented a Bar to be made of Wrought or Malleable Iron, *the original cost of which will be less than the ordinary Cast Iron Bars or Rails*, and, at the same time, will be found to require little (if any) reparation in the course of many years. The Rails or Bars which I have invented are formed as Prisms, though their sides need not of necessity be flat. Figures 1 and 2 of the drawings annexed, shew sections of the Bar thus formed. A is the upper surface upon which the Wheel of the Carriage is to run, slightly convex, in order to reduce the friction; and B is the under part which rests in the supporting Blocks, Chairs, Rests, Standards, or Pedestals, mounted upon the Sleepers. The Wedge-Form is proposed, because the strength of the Rail is always in proportion to its breadth and the square of the depth. Hence this form possesses all the strength of a Cube equal to its square, with only half the quantity of Metal, and, consequently, half the cost. Sufficient strength, however, may be still retained, and the weight of Metal further reduced, by forming the Bars with concave sides, as shewn in section figures 3 and 4. *Indeed, figure 3 is the form of Bar which of all others I prefer for the construction of Railroads, although the Prism, or Wedge-Form, in all its varieties, I claim as being the principle upon which my Patent-Right is founded.* The mode of making these Wedge-formed Rails of Malleable Iron is, by passing Bars of Iron, when heated, through Rollers, having Grooves or Indentations cut upon their Periphery, agreeably to the intended shape of the Bar to be produced; a pair of which Rollers are shewn at figure 5. *Though I recommend and adopt this method as the most eligible means of producing my Malleable Iron Rails, yet* I DO NOT CLAIM THE INVENTION OF THIS MODE OF OPERATING UPON BARS BY WHICH THEY ARE MOULDED INTO ANY SHAPE, *but confine my claim to the exclusive right*

of manufacturing and vending the Wedge-formed Bars or Rails of Malleable Iron of any length, FOR THE PURPOSE OF FORMING OR CONSTRUCTING RAILWAYS OR RAILROADS. The advantages of my improved Wrought Iron Railroads are, first, on the ground of economy; their original cost being less than the ordinary Cast Iron Rails. Secondly, the respective Rails may be made of considerable length, (18 feet I should recommend,) by which the inconvenience of numerous joints is reduced, aud, consequently, the shocks or jolts to which the Carriages are subject, from passing over the joints, (very much to the injury of the Machinery,) are also diminished. And, in order still further to remedy the evil arising from the joint of the Railroad, I propose to weld the ends of the Bars together as they are laid down, so as to form a considerable length of Iron Rail in one piece.

AN

ACCOUNT

OF THE

STOCKTON AND DARLINGTON

RAILWAY:

AND

Extracts from the Report of the Committee

TO

THE PROPRIETORS,

AT THEIR ANNUAL MEETING, HELD AT YARM,

On Tuesday the 10*th of July*, 1827.

AN

Account of the Opening

OF THE

STOCKTON & DARLINGTON RAILWAY

[EXTRACTED FROM THE NEWCASTLE COURANT OF OCT. 1, 1825.]

On Tuesday last, September 27th, 1825, that great work, the Stockton and Darlington Railway, was formally opened by the proprietors, for the use of the public. It is a single Railway of 25 miles in length, and will open the London market to the collieries in the western part of the county of Durham, as well as facilitate the obtaining of fuel to the country along its line and the northern parts of Yorkshire.

The line of Railway extends from the collieries in a direction nearly from west to east, from Witton Park and Etherly, near West Auckland, to Stockton upon Tees, with branches to Darlington, Yarm, &c., and is chiefly composed of Malleable Iron Rails. At the western extremity of the line, a deep ravine occurs at the river Gaundless; on the summit of the hills on each side of which permanent steam-engines are fixed for the purpose of conveying the goods across the two ridges. The engine on the western side of the vale is called the Etherly

Engine, and that on the eastern side the Brusselton Engine; the latter of which, in addition to conveying the goods up from West Auckland, also continues the transit down the eastern side of the ridge: below this, to the east, the country, though undulating, is pretty flat, and the conveyance is performed by locomotive engines. To give *eclât* to the public opening of the road, a *programme* was issued, stating that the proprietors would assemble at the permanent steam-engine below Brusselton Tower, about nine miles west of Darlington, at eight o'clock. Accordingly the committee, after inspecting the Etherly Engine Plane, assembled at the bottom of Brusselton Engine Plane, near West Auckland, and here the carriages, loaded with coals and merchandize, were drawn up the eastern ridge by the Brusselton Engine, a distance of 1960 yards, in seven and a half minutes, and then lowered down the plane on the east side of the hill, 880 yards, in five minutes. At the foot of the plane the locomotive engine was ready to receive the carriages; and here the novelty of the scene and the fineness of the day had attracted an immense concourse of spectators—the fields on each side of the Railway being literally covered with ladies and gentlemen on horseback, and pedestrians of all kinds. The train of carriages was then attached to a locomotive engine, of the most improved construction, and built by Mr. George Stephenson, in the following order:—

1. Locomotive engine, with the Engineer (Mr. Stephenson,) and assistants. 2. Tender, with coals and water; next, six waggons loaded with coals and flour; then an elegant covered coach, with the committee and other proprietors of the Railway; then 21 waggons, fitted up on the occasion for passengers; and last of all, six waggons loaded with coals,—making altogether a train of 38 carriages, exclusive of the engine and tender.

Tickets were distributed to the number of near 300, for those whom it was intended should occupy the coach and waggons; but such was the pressure and crowd, that both loaded and empty carriages were instantly filled with passengers. The signal being given, the engine started off with this immense train of carriages; and here the scene became most interesting—the horsemen galloping across the fields to accompany the engine, and the people on foot running on each side of the road, endeavouring in vain to keep up with the cavalcade. The Railway descending with a gentle inclination towards Darlington, though not uniform, the rate of speed was consequently variable. On this part of the Railway it was wished to ascertain at what rate of speed the engine could travel with safety. In some parts the speed was frequently twelve miles per hour, and in one place, for a short distance, near Darlington, fifteen miles per hour; and at that time the number of passengers was counted to four hundred and fifty, which, together with the coals, merchandize, and carriages, would amount to near ninety tons.

After some little delay in arranging the procession, the engine with her load arrived at Darlington, a distance of sight miles and three quarters, in sixty-five minutes, exclusive of stops, averaging about eight miles an hour. Six carriages, loaded with coals, intended for Darlington, were then left behind; and after obtaining a fresh supply of water, and arranging the procession to accommodate a band of music and passengers from Darlington, the engine set off again. Part of the Railway from Darlington to Stockton has little declivity, and in one place is quite level; and as in the upper part, it was intended to try the speed of the engine; in this part it was proposed to prove her capability of dragging a heavy load, and, certainly, the performance excited the astonishment of all present, and

exceeded the most sanguine expectations of every one conversant with the subject. The engine arrived at Stockton in three hours and seven minutes after leaving Darlington, including stops, the distance being nearly twelve miles, which is at the rate of four miles an hour; and upon the level part of the Railway, the number of passengers in the waggons was counted about five hundred and fifty, and several more clung to the carriages on each side, so that the whole number could not be less than six hundred, which, with the other load, would amount to about eighty tons. Nothing could exceed the beauty and grandeur of the scene. Throughout the whole distance, the fields and lanes were covered with elegantly-dressed females, and all descriptions of spectators.

The bridges, under which the procession in some places darted with astonishing rapidity, lined with spectators, cheering and waving their hats, had a grand effect. At Darlington, the whole inhabitants of the town were out to witness the procession.

But though all along the line, people on foot crowded the fields on each side, and here and there a lady or gentleman on horseback, yet the procession was not joined by many horses and carriages, until it approached within a few miles of Stockton; and here, the situation of the Railway, which runs parallel and close to the turnpike road leading to Yarm and Stockton, gave them a fine opportunity of viewing the procession.

Numerous horses, carriages, gigs, carts, and other vehicles travelled along with the engine, and her immense train of carriages, in some places within a few yards, without the horses seeming the least frightened; and at one time the passengers by the engine had the pleasure of accompanying and cheering their brother passengers by the stage-coach, which passed alongside, and of observing the

striking contrast exhibited by the power of the engine and of horses; the engine with her six hundred passengers and load, and the coach with four horses, and only sixteen passengers.

In contemplating the events of the day, either in a national point of view, or as the efforts of a company of individuals furnishing a speedy, efficacious, and certain means of traffic to a wide and extended district, it alike excites the deepest interest and admiration; and the immense train of carriages covered with people, forming a load of from eighty to ninety tons, gliding, as it were, smoothly and majestically along the Railway through files of spectators, at such an astonishing rate of speed, left an impression on those who witnessed it that will never be forgotten.

Part of the workmen were entertained at Stockton, and part at Yarm, and there was a grand dinner for the proprietors and their more distinguished guests at the Town Hall, in Stockton. Mr. Meynell, of Yarm, was in the chair, and the Mayor of the town acted as vice-president.

STOCKTON & DARLINGTON RAILWAY.

[EXTRACTED FROM THE CALEDONIAN MERCURY.]

EVER since the completion of this great work, the opening of which excited such attention, not only in this country, but throughout Europe, the public have been looking for information as to its operation and success; and we have recently, as already stated, learnt some interesting particulars on these points, which, as they throw new light on the advantages and effects of Railways in general, we are happy to be able to communicate to our readers, premising with a short account of the situation, extent, and other circumstances useful to be known regarding this Railway.

The Stockton and Darlington Railway was undertaken chiefly with the view of opening up the coal-fields which lie in the south-western part of the county of Durham. These form part of the great coal district of the north of England, that stretches throughout the counties of Northumberland and of Durham, in the shape of an irregular oblong, of which the central part lies along the banks of the Tyne, from its mouth to about 20 miles up the river, and the extremes diverge about 30 miles to the north and south, diminishing continually in breadth till they terminate in the upper part of the Tees on the south,

and at the mouth of the little river Coquet on the north. They are distant about 12 miles NW. of Darlington; 24 W. of Stockton; 13 SW. of Durham; and 30 miles SW. of Newcastle; and being situated on the extreme verge of the coal basin, where the coal approaches the surface of the ground, are hence capable of being wrought with facility; while, in the neighbourhood of Newcastle, and along the banks of the Tyne and the Wear, which form the central parts of the mineral deposit, the coal lies at great depth, and the expense of sinking new pits to meet the increasing consumption is enormous. There, it requires the lapse of years, and an outlay of, at least, £100,000, ere an item of coal can be extracted; but, in the more remote parts of the Durham coal-field, a pit may be sunk, and coals of good quality dug out for sale, in the space of a week. All that was wanting, therefore, to render this district productive, was an opening to the great markets of the country, and with this view the Railway was projected, to connect it with the thriving towns of Darlington and Stockton, and, above all, with the shipping port at the latter place.

It commences at the Witton Park and Etherly Collieries, about two and a half miles to the north of West Auckland, and within a mile of the right bank of the Wear, which is here but a small stream, being upwards of thirty miles from its mouth. From thence it runs nearly in a straight line to West Auckland, and continues bending to the east for about six miles further, passing half a mile to the north of Brusselton Tower, and between West and East Thickley, till it approaches within a mile of the great road from London to Edinburgh, at a place termed the Travellers' Rest, about six miles to the north of Darlington. Here it turns quickly round to the south, and runs in a direction nearly due south, and parallel with

the London road, to within a mile of Darlington, where it again bends to the east, crosses the London road, and the river Skerne, on which Darlington is situated; runs eastward almost three miles, turns southward again for another mile, which brings it into the valley of the Tees, and within a mile of the river itself; it then returns to the eastward, and runs parallel with the course of the Tees, until it arrives at Stockton, and terminates at the shipping places on the left bank of the river, which is here navigable for vessels of 150 tons burthen. The distance from Stockton up to Darlington, is about 12 miles—to the bend opposite the Traveller's Rest, 17½ miles—to the foot of Brusselton Hill, 20 miles—to West Auckland, 22 miles —and to Witton Park, the whole length is about 25 miles. In point of level, the line of road is pretty favourable, excepting along the first five miles at the upper end, where, the country being hilly, the line is irregular. It commences in the valley of the Wear, at an elevation of 470 feet above the level of the sea. Between this valley and the river Gaundless, a branch of the Wear which flows by West Auckland, and joins the main stream at Bishop Auckland, a ridge of high ground termed Etherly Hill intervenes, which it is necessary to surmount. This rises to 646 feet above sea level. From the top of this height again the valley of the Gaundless presents an extensive tract of low land, crossing the course of the Railway, and of such width and depth as render it impracticable to be filled up by embankments. The ground here falls to 320 feet.— Here, therefore, the line descends into the valley, and rises again about half as high on the opposite side, to the top of another ridge of high ground which forms the north side of Brusselton Hill. It rises here to the original altitude of 470 feet, from which it again descends a little, until it falls into a more level country, which continues

through the remaining 20 miles of its course, the line from the foot of Brusselton Hill to Stockton forming mostly a varying, but continued and gentle descent the whole way. Irregular as the above line may seem, great pains have been required, and no small expense, in smoothing down the inequalities of the country through which it passes, and forming the line into its present shape. For this purpose, long and deep cuts have been undertaken without scruple; and vast embankments, one of which, in particular, at the foot of Etherly Ridge, is no less than forty feet high.

From the above irregularities in the upper parts of the road, different methods have been resorted to for effecting the transit of the coal along the line. From the Collieries at Witton Park and Etherly the coal waggons are conveyed by horses to the foot of Etherly Ridge, a distance of a mile. Here the horses are detached, and the waggons drawn up the north side of the ascent by means of a steam engine which is fixed on the top, and draws a rope that reaches from it to the foot of the hill, where it is attached to the waggons, and raises them along with it. The distance from the top to the bottom of the hill is about half a mile, and the rise about 180 feet perpendicular. It is such steep ascents which are known in Railways by the name of *inclined planes*, and this one is termed the Etherly North Inclined Plane. At the top of the hill the waggons are attached to another rope, which is of such a length as to reach the low ground on the south side, a distance of upwards of a mile, with a descent of 312 feet. Down this second plane, termed the Etherly South Plane, the waggons descend by their own gravity, and the rope which is attached to them, winding round a barrel at the top, serves to regulate and check their rapid descent, as well as to bring up in their place a similar number of

empty waggons returning from Stockton to the collieries, these waggons being afterwards let down the north side of the ridge, by means of the same rope which brought the full ones up from the collieries. The Etherly South Plane lands the waggons at the turnpike road at West Auckland; and from thence a new set of horses draws them about a mile and a quarter farther, to the foot of Brusselton Hill, up which the waggons are again conveyed by a long rope and fixed steam engine at the top, in the same manner as on Etherly Hill, and are again let down to the foot of the hill on the east side; these ascents and descents forming the Brusselton West and East Inclined Planes. The ascent up the former is upwards of a mile in length, and 150 feet perpendicular. The descent is less than half a mile, and about 90 feet perpendicular. From the bottom of Brusselton Hill no farther interruption occurs in the line, and the waggons can be thence drawn all the way to Stockton either by horses or by locomotive engines. The descent, however, varies in different places from a perfect level to a descent of 1 in 104. This Railway forms throughout only a single line, with three or four passing places in every mile, by which one set of waggons can pass clear of another. The Rails are mostly of Malleable Iron Patent Rails from Bedlington Iron Works, which, from their great length and other advantages, have in this, as in other instances in which they have been tried, proved the best form and material in use. The whole expense of the Railway has amounted to about £150,000.

Such, then, is the nature, extent, and peculiar circumstances of this Railway. The facilities which it presents for the transport of coals, or other materials, or goods, are immense. On a common turnpike road, it is well known, a horse seldom draws more than sixteen cwt. or a ton;

but on the level or slightly-descending parts of this line a single horse can draw, with ease, four waggons, containing each a chaldron of 53 cwt. of coals, besides the weight of the waggon itself, of 24 cwt., in all nearly 16 tons, travelling with this at the rate of three miles an hour, and going at an average 24 miles a-day, but frequently making a trip from Brusselton to Stockton and back again, a distance of forty miles. The above is the performance in the lower parts of the line, where, however, the descent is in many parts far from being the most favourable for returning with the empty waggons. It is important to remark, that in another part of the line, namely, the flat between the Etherly and Brusselton planes, a single horse draws double of the above load, or upwards of 30 tons, owing chiefly to the short distance, and the uniform and gradual descent. Up the steep ascents of the inclined planes, again, the fixed steam engines, of which the Etherly engine has a power of 30 horses, and the Brusselton of 60, draw eight loaded waggons, equal to 21 tons of coal, and ten tons in the weight of the waggons, in all 31 tons, and this at the rate of from eight to ten miles an hour. But it is the locomotive engines which shew, in the most striking light, the extent of power which the Railway system places at our command. Each of these machines, of which there are two constantly at work, and one, if not two additional in preparation, draws after it 20 waggons, and frequently 24, each loaded as above, and forming in all a mass of 77 tons in the one case, and 92 in the other; and this enormous load is now regularly conveyed by each of these engines from Brusselton plane to Stockton, a distance of 20 miles, in four hours; the engine returns again in five hours with the empty waggons; and, including an hour spent in stoppages, completes the journey in ten hours; so that, if necessary, it could easily make two trips

in one day and night, and thus deliver into the ships between 500 and 600 tons per week, which is equal to the work of 12 or 14 horses in the same circumstances.

In our last paper we endeavoured to describe, generally, the nature and objects of this important undertaking, with its situation, extent, direction, and other local and peculiar circumstances regarding it; and we were proceeding to give an account of the facilities which it affords for internal trade, and of the extraordinary loads which can be transported along it, by the power either of animals or machinery. The great obstacle, it is well known, to the transport of goods or other commodities, arises from the irregularity and roughness of our roads, the surfaces of which present a series of little eminences, over which the carriage must be continually dragged, as it advances in its course. It is not merely the inertia of the mass which is thus to be overcome in impelling the carriage, and which every one knows forms no obstacle at all, excepting only at the moment of starting. When once the carriage or body, whatever it be, is set in motion, it would go on without any further effort, if it met with no obstruction on the way. Along our roads, however, as experience shews, it requires a continued exertion to keep the carriages in motion; and the reason is, that they are subject not only to a progressive motion, but also to one of continued ascent and descent over the inequalities of the way. Our roads, no doubt, with the modern improvements, appear now remarkably smooth; but still, when carefully examined, they will be found, in reality, full of asperities, which, though minute to the eye, still constitute real elevations and depressions, on which the carriage, as it advances, is continually rising and falling; and it is the incessant lifting of the whole mass over these protuberances which chiefly constitutes that drag we experience, even on the

smoothest of our turnpikes. The great object of a Railway, therefore, is, to remove all these obstructions along the road, and this it does by laying tracks so uniform and smooth in their surface, that the carriage rolls along entirely free from that undulatory motion, which, in ordinary cases, forms such a complete waste of our powers of draught. Simple as this idea is, its execution is by no means easy; it is attended with great expense, and requires, moreover, a highly-improved state of the sciences and arts to give full effect to the principle. It is only, therefore, in a country like ours, with an overflowing capital, and abounding in intelligence and practical skill, where such a scheme can be thought of, however well the nature and elementary principles of the design may be understood and valued, as they have been indeed among men of science for a long time back. Accordingly, it was not until the middle of the seventeenth century, that we find any traces of the art of laying Railways. It then appears to have been introduced, in a very rude way, among the collieries in the neighbourhood of Newcastle, where the immense traffic in conveying coals from the pits to the places of shipment on the Tyne, rendered any contrivance of the kind of peculiar utility and value. Since that time it has been constantly in use, and receiving from time to time continual improvements, with the progress of the different arts on which it depends for its perfect construction; and it is remarkable, that in proportion as these improvements have been introduced, the means of conveyance have been invariably increased. Every change which has contributed in any degree to render the way more smooth, even, and continuous in its surface, whether by introducing harder, smoother, or more durable materials, than formerly; or seeking out and forming a more solid basis for these to rest on; or uniting the different pieces

with closer or more perfect joinings, has in exact proportion, by easing the draught, added to our powers of traction. The first Railways, which were of wood, although much superior to the roads then in use, were probably inferior to the present turnpike roads, on which a horse draws about 15 cwt. at an average. Such, however, is the perfection to which the art has now arrived, that, as was previously stated, a single horse on the level or slightly descending parts of the Darlington Railway, the effect being no doubt partly aided by the descent, can draw a weight of 16 tons, *i. e.* as many tons can be drawn on the Railway, as cwts. on a common road; and each of the locomotive engines draws a weight of 90 tons, and can convey from Brusselton to Stockton, a distance of twenty miles, and deliver into the ships, from 500 to 600 tons of coal weekly.

With such prodigious powers of locomotion and trackage, no wonder that the expenses of transport should have been greatly reduced; and to such an extent has this been effected, that the company have actually let the haulage of their coal, they furnishing the engines and waggons, at one farthing per ton for each mile, which price is understood to pay the contractors well, and the company themselves are enabled to carry coals from Brusselton Hill to Stockton, at the rate of one penny per ton for each mile, the Railway dues being one half-penny, and the other expenses one farthing. On the inclined planes sixpence per ton, in addition to this, is charged on each for the use of the machinery. Between Brusselton Hill, however, and Stockton, the way is free, and here the company, as we stated, are enabled to convey and deliver coals into the ships on the Tees, at the rate of one penny per ton for each mile, or at 1s. 8d. for the whole twenty miles. On coals for land sale the dues are rather higher, and also on

lime and other articles; but still the prices are very low, and such has been the effect in the market, that coals at Stockton, which formerly sold at 18s., are now selling for 8s. 6d. per ton. The above fact of the low price of carriage is really surprising, and we believe quite unprecedented in the annals of inland traffic: and, had the execution of this Railway done nothing else than to have ascertained and proved it, by its daily and weekly practice for nearly a twelvemonth together, it would have conferred a signal benefit on the country, and even on the nation It certainly reflects the highest credit on the authors and promoters of the design, who, we understand, were chiefly belonging to the Society of Friends, and persevered in their plans under many difficulties and discouraging circumstances, but who may now look with satisfaction and pride on an act which does honour to themselves, their country, and the age in which we live. Coals, and, of course, other materials and goods, in the same, or nearly the same proportion, may be conveyed to a distance, at the charge of one penny per ton for each mile. What a train of important consequences does not this single fact involve; and, as this can be done in other places, what a wonderful field is thus opened for internal improvement! At present we are paying, on our best turnpike roads, as much as this, and more, for tolls alone, and six or eight times as much for all the expenses of carriage. Coal, for example, from the vicinity of Dalkeith, costs in Edinburgh, which is only six miles distant, 4s. per ton for carriage alone, which, at the above rates on the Railway, would amount to only 6d.; and coal imported at Leith costs 3s. 6d. per ton for the carriage up to Edinburgh, and as the distance is only two, or at most only two and a half miles, the carriage by the Railway would cost only 2½d. Coal also from the Union Canal Basin costs 1s. 3d.

for carriage to the centre of the town, the distance of which is scarcely a mile. Stone, again, for our buildings in Edinburgh, from the great quarries of Craigleith and Hailes, distant, the former two miles, and the latter four, from the centre of the town, cost respectively 2s. 2d., and 3s. 2d. per cart, or 2s. 8d. or 3s. 11d. per ton for carriage, while, by the Railway, it would only come to 2d. and 4d., and any additional charge for carrying along the streets and delivery might bring it to 4d. and 8d. Between Glasgow and Edinburgh, one of our greatest thoroughfares, the carriage of such articles as are usually conveyed along that road, costs some £1, and others as high as £5 and £6 per ton; the average may run about £2, and the distance being 44 miles, this is very nearly at the rate of 11d. per ton for each mile. Even canal navigation comes much short of the above standard of one penny a ton per mile. On the Union Canal, for example, coals shipped from Redding Colliery, cost at Port Hopetoun 4s. 6½d., for the expenses of transport, and the distance being 26 miles, this is at the rate of 2d., or double the expense by the Railway. But the distance by the road is only 22 miles, and by a proper Railway would be no greater; and this brings the comparative expense up very nearly to 2½d. a ton per mile. On the Monkland Canal, again, in the neighbourhood of Glasgow, the distance from one of the coal pits to the Monkland basin is 10½ miles, and the expense of transport 2s. 2d., which is at the rate very nearly of 2½d. per ton.

Such, then, is the superiority of this new mode of conveyance, over every other that has hitherto been invented. In our next paper we shall follow out the details, and, in particular, give a view of the advantages that would result to the public from a Railway between Edinburgh and Glasgow.

RAILWAY

BETWEEN

EDINBURGH AND GLASGOW.

[EXTRACTED FROM THE CALEDONIAN MERCURY.]

In our last paper, we illustrated the economy of Railway conveyance, as compared with our present roads, and even with canal navigation. In respect to the latter, we have another striking example in the conveyance of goods between Glasgow and Edinburgh through the Forth and Clyde and Union Canals; the expense of this runs from 15 to 24 shillings per ton; it may be averaged at 21 shillings; and the joint length of the two canals being nearly 57 miles, this is at the rate of 4½d. per ton for each mile; but, if we take the distance between the centres of the two cities, as it is by the Shotts and Bathgate roads, at 44 miles, this brings it up to 5½d.; and yet it appears the Darlington Railway Company are conveying coal at the rate of 1d., and we see nothing to prevent the average of goods from being done at 2d. per ton for each mile, by which means the conveyance between Glasgow and Edinburgh might be reduced to 7s. in place of 21s. These facts are remarkable, and well worthy of attention. The

traffic between Glasgow and Edinburgh, and between the Forth and the Clyde, which lead immediately into the opposite seas, is so great, that a direct line of communication between them has been a long-desired and much-agitated project, and various lines of canal have been at different times surveyed, but none of them appear capable of effecting the object so simply and effectually as the Railway. The distance between the centres of the two cities could not on it exceed 44 or 45 miles, and between the port of Leith and the shipping quays of the Broomielaw on the Clyde, 48 or 49 miles; but allowing 1s. 6d. for the use of inclined planes, or any other extraordinary charge on the line, still the cost of transport might be afforded at 7s., which would produce an immediate reduction of three-fourths of the expenses by the roads, and of two-thirds of their amount by the canals. The consequences of this would be certain; a great proportion of the traffic between the two cities, as well as between the two seas, would naturally flow into this new and improved channel of communication. The annual expenses of this trade at present cannot be estimated, we should think, at less than £150,000 or £180,000 a year. A saving, therefore, would arise of upwards of £100,000 a year: and the effect of such an accumulation of capital, overflowing into new channels of profitable employment, would be astonishing. Some have doubted whether this scheme would pay its own expenses, but the above facts, we should think, will set this matter at rest. It is not so much, however, the trade as it is at present carried on, that we are to look to; we may count with certainty on a vast increase from such an extraordinary reduction in the rates of conveyance. Look at the important facts which are now passing under our eyes in the case of the Fife Ferries; the reduction of fares here, in crossing the Forth, from 2s. and 1s. 6d., to

1s., and 6d., together with the advantage of more frequent trips, have, at the very outset, nearly quadrupled the intercourse on the passage. Besides this, the line of such a Railway passes through a country rich in coal, ironstone, limestone, freestone, and other minerals. About 23 miles from Edinburgh, on this line, lies a most extensive coal field, known by the name of Benhar, containing seams of the finest quality, not inferior to the jewel coal of Mid Lothian. This coal is exactly in the situation of that already described in the county of Durham; it lies at no great depth, is hence easily worked, and only requires an opening to pour an inexhaustible supply into our market. It sells at present, on the hill, at 5s. per ton; and, according to the Darlington rates, 1s. 10d., or say 2s. more, would bring it into Edinburgh, where it could thus be sold at 7s. per ton—the prices of the most inferior coal being now from 11s. to 12s., and of the best jewel coal from 15s. to 17s. In these circumstances, the consumption of the Benhar coal would be immense—it would either bring down the general prices, or acquire the complete ascendancy in the market; and as Edinburgh, exclusive of Leith, consumes 300,000 tons annually, it is but a moderate estimate, considering the increase of consumption which would arise from the reduction of price, to reckon 200,000 tons passing by the Railway. This, at the rate of one halfpenny per ton of Railway dues, for each of the 23 miles, would yield a revenue of about £9,500 a year, which alone would, at 5 per cent., pay an expenditure of £190,000. But on the west end of the line also, and nearer to Glasgow, the line passes through and near to other very extensive coal-fields, containing seams of great thickness, of excellent quality, and favourably situated for working. These are known generally by the name of the Glasgow Coal Fields, or the Coal Fields of the Clyde. They stretch

along the banks and valley of that river, from the neighbourhood of Glasgow, for about twenty miles higher up, with an average breadth of eight miles. They occur in different seams, with various strata of stony and earthy substances interposed, all dipping towards the river on either side, until they approach the north and south extremities, where they wheel round, and mutually unite together, the whole forming one of those remarkable basins of mineral deposit which occur so frequently in our island, and afford, by the peculiar and admirably regular disposition of the strata, illustrations of the natural history and geological structure of our globe, at which even the philosopher pauses with curiosity and surprise. The whole district, comprehending an area of 160 square miles, forms an entire mass of coal, of which the aggregate thickness of the different seams varies from 12 to 30 feet. "Taking it all in all," say the mineral surveyors who were appointed to examine these districts by the subscribers to a canal, in the year 1794, "there are few such extensive coal fields to be met with; and so little of it has been worked, it can scarcely be said to have been yet begun upon." So that this store of mineral riches has hitherto laid dormant, owing to its distance from the great centre of business, the upper parts of it, where it could be worked with advantage, being distant from 10 to 15 miles from Glasgow. But it is in the power of art, we have seen, to conquer distance; and the Railway would open up this treasure almost as if it had lain in the suburbs of the city. Glasgow consumes annually 600,000 tons of coal, and exports, besides, great quantities to Ireland, and these appear to be only limited by the present high price, which in Glasgow runs at from 9s. to 11s. per ton. The whole quantity at present raised in the collieries in the above districts, is between 700,000 and 800,000 tons; so that we may safely

calculate on 300,000 tons passing by the Railway. This, at one halfpenny per ton for each of the 10 miles of average distance for Railway dues, would yield a revenue of upwards of £6,250 a-year; and adding this to the £9,500 drawn from the eastern side of the line, we should have, for coal alone, £15,750 a-year; which, at 5 per cent., would cover an expenditure of £315,000—a sum which would go undoubtedly far to execute such a work, seeing that the Darlington Railway, for 25 miles, with several branches, cost only £150,000. Besides coal, the limestone and ironstone on the line would form valuable sources of revenue. Within 11 miles of Edinburgh, in the neighbourhood of Mid-Calder, immense strata of lime rock occur, no less than 40 feet thick. In one of the quarries belonging to the Earl of Morton, the workings have never reached the bottom, which is supposed to lie at the depth of 60 feet. In the Glasgow coal fields, again, according to the mineral surveyors, there are, at a considerable depth below the coals, "very rich fields of lime and iron stone intermingled, and alternately there is one limestone band, and many ironstone bands as far as these fields have yet been fathomed." Most of the iron, also, from the Shotts, Omoa, and Clyde iron works, and others, would pass along the Railway. In short, whether we consider the extent and value of the thorough trade, and of the traffic from city to city, which this line of communication would engross, or the supplies of mineral, agricultural, or other produce which it would convey from different parts of its course to the great markets at either extremity, or the new and various branches of trade and business which would spring up along the line or in the two cities, in consequence of the new facilities of intercourse, and the cheapness of rude produce; such a work would not only become profitable to the undertakers of it, but of singular

benefit to either city, as well as to the whole of the surrounding and intermediate country. And it is only, we have no doubt, owing to the late melancholy stagnation in trade, that this work, as well as others of a similar kind, which, as our readers are aware, were lately in agitation, have not been already commenced. The survey, however, we have recently understood, is completed, and, along with the engineer's report, will soon be printed, when we shall take another opportunity of describing more particularly the line of its direction, and various other circumstances connected with this great design.

The above facts, then, of the low price of land conveyance, lead, as we have already observed, to a variety of important consequences. Hitherto the Railway system has been viewed only as an auxiliary to inland navigation, or with a view to speedy travelling, and the conveyance of light goods. But these place the subject in quite a new light. They prove that even for the conveyance of heavy goods, where speed is not absolutely necessary, the Railway is superior in point of economy, the speed of conveyance making up for any deficiency in the power of trackage. It has in every respect, therefore, the advantage, and must, sooner or later, become the principal medium of our inland trade. If, indeed, such reductions in the expenses of carriage can be effected by means so simple, there is no doubt that these will speedily be adopted in all our great thoroughfares, and must supercede every other species of conveyance, where there is a carrying trade of any great consequence; besides opening up new and easy lines of communication throughout the country, and pushing the resources of trade and intercourse into districts hitherto shut out from their beneficial and all-improving influence. And when we consider the immense sums now spent in accomplishing the active and busy traffic which is continually

going on in the various districts of this great commercial country, and the heavy tax which it imposes on trade and industry, the consequence of such a revolution must be in the highest degree important. The saving on the expenses of transport would be prodigious; and this, together with the increased facilities of intercourse, would give rise to an immense increase of business; while the most remote districts of the country would be explored, to furnish materials for our improving trade and manufactures, for the supply of an expanding population, and a rapidly-increasing consumption of all the articles of convenience, luxury, and taste. Every branch of trade would participate in the general improvement, while new and innumerable sources of productive industry would arise for the employment of the various classes of our people. In short, the whole community would feel an impulse of which it is impossible to calculate the effects; but should we live to see fully developed all the powers and energies of this system, we have no doubt it would prove one of the greatest benefits which philosophy or art has ever conferred on society.

But such is the extent and variety of discussion into which this subject has led us, that there is still one branch of trade on the Darlington Railway which we have not touched on, and which is even more surprising and replete with important consequences than any other; we mean the conveyance of passengers and light goods. This we shall describe in another paper.

CONVEYANCE

OF

PASSENGERS AND LIGHT GOODS.

[EXTRACTED FROM THE CALEDONIAN MERCURY.]

Of all the advantages of the Railway, the remarkable velocity of motion which it admits of, and which fits it so admirably for the conveyance of passengers, light goods, and mails, is the most striking and the most valuable, in a country where these objects are becoming every day of more and more importance. This property it derives from the original principles already explained, on which its efficiency depends, namely, the removal of all obstructions out of the way of the moving body. Could this be done entirely, it is evident that the facility of motion would be perfect—the most enormous masses, so long as they continued on a level plane, might then be moved along the way with the smallest effort, and by a continued application of power their velocity might be increased without limit. Such perfection, however, can never be attained; for, independent of those gross and palpable obstructions which arise out of the rough materials of our common roads, there are still others arising from the

friction and adhesion, even of the smoothest surfaces, which, as they are founded on the intimate nature and constitution of matter itself, it is impossible to remove. Let the natural roughness of bodies be ground down ever so smooth, still we experience, on drawing the one along the other, a resistance known in mechanics by the name of *friction*, and which may be reduced, but cannot be destroyed by the most elaborate polish. Even when, instead of drawing, we only roll the one along the other, although there is then no rubbing whatever, still we find a degree of resistance from the mere contact of the surfaces, which the smoothness of these may diminish, but cannot altogether remove. These resistances rank among the most remarkable phenomena in natural philosophy; the cause of them is quite unknown, but is justly ascribed, according to the ingenious theory of Professor Leslie, to some internal motions among the particles of matter, the nature of which, from their extreme minuteness, and our utter ignorance of the laws which connect these elementary atoms, and form them into a body, will, probably, ever remain concealed. All that we can do, therefore, is to diminish, as much as possible, these resistances, by smoothing the rubbing and rolling surfaces, both of the carriages and of the ways, or by any other means which experience may suggest. Fortunately, however, there is one remarkable circumstance connected with these obstructions, which is highly favourable for the purposes of speed. It appears, from the experiments which have been made by various philosophers on the subject of friction, that it is nowise increased by the motion of the bodies themselves, however rapid this may be. Suppose, for example, a sledge is drawn along the ice at the rate of two miles an hour; then, according to these experiments, it follows, that if it were drawn at four miles, at eight, at twelve miles, or at

any other velocity, no increase would be felt in the resistance arising from the friction of the rubbing surfaces. This presents the same constant retarding force, whatever be the quickness of motion; so that when once this retarding effect is overcome, there is nothing but the mere inertia of the mass to prevent the body from being impelled with any velocity whatever. It may, no doubt, require a greater effort on the part of the animal to drag it with such velocity; but this arises not from any increase in the resistance arising from friction, but from the difficulty which all animals feel in increasing their own speed, and the cause of which is of the same nature as that already explained which retards a carriage on a common road. The animal advances, not with a continued progressive motion, but with a sort of irregular hobbling, which raises and sinks its body at every alternate motion of the limbs. This is distinctly felt on horseback, and it is the same when the animal draws a load. Even in walking or running one does not move regularly forward. The body is raised and depressed at every step of our progress: it is this incessant lifting of the mass which constitutes that drag on our motions which checks their speed, and confines it within such moderate limits; and it is this effect, and not any increase of friction arising from the velocity of the moving body, which requires such efforts on the part of animals to increase the speed of their load even on the smoothest tracks. With machinery this inconvenience is not felt; the locomotive engine rolls regularly and progressively along the smooth tracks of the way, wholly unimpeded by the speed of its own motions; and this, independent of its economy, is one of the great advantages it possesses over animal power. Such is the nature of that resistance to our motion along a Railway, arising from the rubbing of the parts; but which is in all

cases greatly diminished by setting the carriage on wheels, and thus confining the rubbing surfaces to the line of the axle and nave. Still, however, there remains the resistance arising from the rolling of the wheels along the way; and, from what has been observed, this resistance appears to follow similar laws with the other. Experiments are no doubt still wanting on this point; but some have lately been made by Mr. Wood, of Killingworth, author of a work on Railroads, which forms the best practical treatise on that subject which has yet been published; and we are informed by him, that, on rolling wheels down an inclined plane, loaded with weights to the amount of one or two tons, no sensible increase of resistance was observed from the speed of their motions, any more than in the case of friction itself. Whether we consider, therefore, the resistance on the Railway, arising from the rubbing of the surfaces in contact, or from their rolling the one along the other, they appear, by the laws to which they are subject, equally favourable for the purposes of speed. Obstructions they will always be in our way; but still, so long as they only present themselves in the shape of a constant retarding force, they can be easily overcome by the powers which nature and art place at our command. We have in them a certain determinate force of retardation opposing our motions; but in that case we have only to apply to our machinery a constant force of acceleration of equal intensity. We have, then, force opposed to force, and a very small preponderance of power will be sufficient to impel the machine with any velocity that may be desired; at least with any velocity which it would be safe on other accounts to attempt. How different is the case in navigation. The fluid element supports, no doubt, and floats on its surface the most gigantic masses with admirable and perfect effect, and seems even to remove every

obstruction to their motion, except mere inertia, such is the facility with which they roll, or can be moved about in any direction, by a comparative nothing in the balance of weight and power. This, however, is a mere deception. For no sooner does the vessel acquire any degree of velocity in the water, than the resistance of the dense medium becomes apparent. The obstructions to its progress seem to accumulate with every attempt that we make to urge her forward; and whatever amount of power is applied for this purpose, a limit of speed is soon attained beyond which it becomes impossible to advance any further. This is well exemplified by the tracking on rivers or canals. We there see the animal straining to its utmost, and yet continuing to plod at the same slow, yet weary and difficult pace, drawing, no doubt, an enormous load, but unable to advance it with any degree of speed. Even at sea, the power of the winds, let it be ever so strong, is incapable of impelling a vessel beyond a certain rate, which seldom exceeds ten or twelve miles an hour. There is something, therefore, in the nature of the fluid medium extremely adverse to rapid motion. It presents a resistance, not constant like friction, but continually increasing with the velocity of the moving body, and this even with an accelerated progression, which soon checks every attempt to get the better of it. The motion on a Railway is subject to no such formidable opposition. The resistances here, on the contrary, are of such a nature as to become rather favourable to speed; for the quicker we move along the way, the less time is there for the retarding force to operate; by advancing, therefore, with rapidity, we escape in some degree from its influence, and may, therefore, be really impelled with a less amount of moving force, provided the machinery be adapted to move with the requisite velocity.

Such are the principles on which the operation of the Railway depends for the rapid motions it admits of. Time and experience of its effects must no doubt be required to carry these principles fully into practice, as in all cases, and particularly one of such magnitude and importance, and requiring, as we have already stated, the aid of so many concurring circumstances, it is long ere the refinements of theory can be realized. Still the sure principles of science must in the end prevail, and give the Railway, where speed is required, the decided pre-eminence above every other mode of conveyance.* And it is satisfactory to find the operations of the Darlington Railway, so far as they go, confirming by experience all these views of the subject. The following is the account of them:—Railway coaches are now plying regularly on the level part of that way, one between Darlington and Brusselton, which runs once a day and back again, and two between Darlington and Stockton, which run each twice a day and back. These coaches are each drawn by a single horse, and yet carry six passengers inside, and from fifteen to twenty outside, besides a due proportion of luggage, and run at the rate of ten miles an hour. The above seems an enormous load for one horse to run with, and at such speed; and yet, to look at the animal, it appears to make scarcely any exertion, certainly not so much as a horse in a gig. It is only occasionally that he gives the vehicle a pull; at other times, even in ascending from Stockton to Darlington, the traces seemed to hang quite loose; and by far the greatest exertion appeared to consist in keeping up his own motion. The same horse

* These principles of friction and resistance have been long known among philosophers. But we are indebted to some able papers from the pen of Mr. Maclaren, for calling the public attention to them, and explaining their various applications.

which runs the coach down from Darlington to Stockton, brings it up again the same day. The coach consists merely of the body of a common inside and outside heavy coach set on a strong frame, with four wheels adapted for the Railway, and considerably smaller than those of a carriage. The frame appeared too strong and heavy, and improvements might be made on this as well as on other parts of its construction, which seemed far from being the most suitable for this new mode of travelling. The coach had no springs of any kind, and yet the motion was fully as easy as in any coach on the roads. A very slight jolt is felt, accompanied with a click or rattle, every time the wheels pass over the joints of the several rails, and also at the breaks which occur at the different passing places, and these, if any thing, feel harsher than in a coach, but in other respects the motion is fully smoother and easier, and with a set of good springs would far surpass any thing hitherto experienced on the best turnpikes. The coach never turns on the Railway, but can be drawn either backwards or forwards with equal facility; the horse being merely unyoked from one side and yoked to the other, which is done in less than half a minute. To suit this arrangement, the front and back of the coach are made exactly alike, with the seats for the coachman, guard, and passengers, the same at either end, and the yoking place for the horse. Such is the extreme mobility of the whole vehicle and its load along the Railway, that when once set in motion, it is not easy stopping it; it is not enough here to "pull up," according to the coachmen's phrase it requires an apparatus for the purpose, termed a brake, the operation of which is peculiar. It consists of a long arm or lever, turning on a centre between the fore and hind wheels at one side, reaching from thence up to the coachman's box, and having a short arm below, which,

by moving the long one, can be made to press strongly on the rim of the wheels, and this creating a considerable friction, soon brings the carriage to rest. When the carriage is in motion, the long arm of the brake rests on a hook under the coachman's seat; and when he wishes to check the motion of the vehicle, or to stop it altogether, the driver unlocks the brake, sets his foot on the extremity of the long arm, and pressing the short one against the wheels, this instantly checks the motion, and gives him the complete command both of the coach and the horse, let these be moving ever so rapidly. At any bends of the road, or other places where the view is obstructed, the coachman blows a horn to give warning of his approach to any waggons or vehicles that may be coming or going on the way; and in meeting or passing, either the coaches or the vehicles go off into some of the passing places, and then return into the main line. On some occasions it happens, through inadvertence or other cause, that both coaches meet in a place between two passings, and when neither of them can get out of the way of the other: things seem approaching to a complete stand, when one of the coachmen unyokes his horse, reyokes him in an instant to the opposite end, and draws the carriage back to one of the passing places, which he enters, allows the other coach to pass, and then resumes his course. The whole affair is managed with surprising facility, and it is wonderful how little these obstacles, which appear at first sight very serious, really obstruct the progress of the traffic; although undoubtedly the true remedy is to have a double line of rails the whole length of the way. "It was on our way from Brusselton to Darlington," according to the journal of our informant, "that we met the Express coach coming up, and which was viewed with much interest, being the first of the kind we had ever seen; it was

well loaded, having sixteen outside, and six inside passengers; it was drawn by one little pony, and seemed to be going at the rate of nine miles an hour. Next day we mounted, ourselves, on the top of the Defence coach, and started from Stockton, highly interested with the novelty of the scene, and of this new and extraordinary conveyance. Nothing appeared more surprising than the rapidity and smoothness of the motion, considering that the coach had no springs; and also the ease with which the animal drew his load. Most of the way is laid with rails eighteen feet long, and here the only irregularity in the motion arose from the joinings of the rails, at each of which the coach gave a very slight jerk. This, however, we have no doubt, will be greatly reduced, if not entirely removed, by an improved mode of joining the rails, which has since been introduced, and consists in lapping the one over the other at the joints. Some parts of the way were laid with rails of cast iron, joined at every four feet, and in coming upon these, the difference of motion and of feeling was quite remarkable. The jerks and jolts, in passing over the joinings of the rails, were more frequent, more audible, and more sensible, resembling exactly, as the coachman justly observed to us, the clinking of a mill hopper; and the whole motion was more irregular and harsher than before, although still far more easy than in a similar vehicle on a common road. Nothing, however, demonstrates more clearly the advantage of long rails and few joinings, and the importance of forming these with all the accuracy which can possibly be devised. We left Darlington with thirteen outside passengers, and two or three inside, and picked up various others on the way. In regard to passengers, the coach appears to be no way limited in its numbers. The coachman informed us that one day lately, during the time of the Stockton races, he

took up from Stockton nine inside and thirty-seven outside, in all forty-six. Of these some were seated all round the top of the coach on the outside, others stood crowded together in a mass on the top, and the remainder clung to any part where they could get a footing. On that occasion he had two horses. We started from Darlington at fourteen minutes past eight, and arrived at Stockton at thirty-five minutes past nine, making the journey of twelve miles in one hour and twenty-one minutes, including eleven minutes at least spent in taking in and letting off passengers. This is fully at the rate of ten miles an hour. But on comparing the speed in different parts of the way, which is easily done by means of posts which are erected at every quarter of a mile, we found it frequently as high as fourteen miles an hour. We again left Stockton at twelve minutes past one, with fifteen outside passengers, and two or three inside, and arrived at Darlington at twenty-five minutes past two. The fare for outside passengers is only one shilling for the whole twelve miles, and for shorter distances at the rate of one penny per mile. The inside fares are exactly double of this."

Such, then, is the first great attempt to establish the use of Railways for the general purposes of travelling, and such is the success with which it has been attended, that the traffic in this way is already great; and, considering that there was formerly no coach at all on either of the roads along which the Railway runs parallel—quiet wonderful. A trade and intercourse has arisen out of nothing, and nobody knew how. It was unlooked for even by the promoters of the Railway themselves, who now draw at the rate of £400 or £500 a-year for the coaches alone; and, altogether, the circumstances of bustle and activity which now appear along the line, with the crowds of passengers going and returning, form a

matter of surprise to the whole neighbourhood as well as to the public.* In our next article, we shall conclude the subject of Railways, by illustrating the importance of these facts, and going into details of their application, particularly to the conveyance of the mails between Edinburgh and London.

* The writer of this article is now engaged in preparing for the press a more copious account of this Railway, as well as a General History of Railways—from which much useful and interesting information may be expected.

EXTRACTS

FROM THE

Report of the Committee to the Proprietors

OF THE

STOCKTON & DARLINGTON RAILWAY,

AT THEIR ANNUAL MEETING HELD AT YARM,

On Tuesday the 10th of July, 1827.

The Committee of the Stockton and Darlington Railway Company, in presenting to the general meeting of proprietors the following report and abstract of accounts, embrace the opportunity of congratulating their fellow-proprietors upon the steadily-increasing importance of the concern, which is most satisfactorily demonstrated by the monthly statement of receipts.

It must be a cause of satisfaction to those with whom this undertaking originated, to find that it meets with such decided support from the public, and to see those opinions which, a few years ago, were by many considered empty and delusive, proved to have had their foundation in clear and enlightened views of the best means of promoting the interests of commerce, and diffusing general prosperity.

* * * * * *

As regards the present traffic on the Railway, each month of this year, as compared with the corresponding months of the past, with the exception of *January*, (in

which the way was repeatedly interrupted by heavy falls of snow,) will show a progressively advancing tonnage on articles consumed in the districts through which it passes; and your committee cannot but calculate that a further augmentation will follow.

With respect to the shipping trade, the quantity of coals exported has surpassed your committee's most sanguine expectations; having, in the last three months alone, considerably exceeded the total amount contemplated in the prospectuses which were issued at the commencement of this undertaking.

* * * * *

It may be satisfactory to the general meeting to be informed, as the result of a strict scrutiny into the subject, that there appears to be a saving of nearly 30 per cent. in favour of the haulage performed by the locomotive engines, when compared with its being done by horses.

* * * * * *

In conclusion, your committee would express their continued conviction that the *Stockton and Darlington Railway* will still effect greater things; and that whilst its benefits are more widely extending, the proprietors have good reason to anticipate the realization of their prospects of pecuniary remuneration.

RECEIPTS FOR TONNAGE, &c.

1825.	*Coals.*			*Lime.*			*Lead, Timber, Merchandize, &c.*			*Coaches.*			*Sundries*			*Total.*		
	£.	*s.*	*d.*	£.	*s.*	*d.*	£.	*s.*	*d.*	£.	*s.*	*d.*	£.	*s.*	*d.*	£.	*s.*	*d.*
October to December,	1994	1	4	28	14	0	22	11	11	86	4	0				2131	11	3
1826.																		
January to March,	2710	16	11	17	7	4	150	4	6	97	5	5				2975	14	2
April to June,	3279	18	8	422	15	5	234	2	3	50	0	0				3986	1	4
	7984	16	11	468	16	9	406	18	8	233	9	5				9094	1	9
1826. 1827.																		
July to June,	14455	5	2	1026	16	10	1240	4	1	563	14	9	1018	3	6	18304	4	4
	22440	2	1	1495	13	7	1647	2	9	797	4	2	1018	3	6	27398	6	1

LIVERPOOL & MANCHESTER RAILWAY:

(EXTRACTED, BY PERMISSION, FROM)

AN ACCOUNT

OF THE

LIVERPOOL AND MANCHESTER

RAILWAY,

By HENRY BOOTH, Esq.,

TREASURER TO THE COMPANY.

The project of the Liverpool and Manchester Line was first discussed as early as 1822.

In the year 1824, a deputation, consisting of Mr. Saunders, the late Mr. Lister Ellis, Mr. Kennedy, of Manchester, and the writer of this account, proceeded to Darlington, where the Railway was then unfinished, and afterwards to the neighbourhood of Newcastle and Sunderland, where various Railways were in operation, and where both Locomotive and fixed Engines were employed for the conveyance of coals from the pits to the respective places of shipment. This deputation made their report to a committee of gentlemen in Liverpool, of which John Moss, Esq. was chairman, on the 20th of May, 1824,

when it was finally determined to form a Company of Proprietors for the establishment of a double Railway between Liverpool and Manchester.

Such, then, was the scheme of the Liverpool and Manchester Railway, requiring, however, the sanction of the legislature before it could be carried into effect. Parliament met early in the ensuing year, and a portion of the Railway committee attended in London in the first week of February, 1825, to watch the progress of the bill through the House of Commons—an undertaking by no means a sinecure, as those who have had the good or ill fortune to be concerned in carrying forward contested bills will readily admit.

On the 8th of February, 1825, the petition for the bill was presented to the House of Commons.

On the 18th of February, the Bill was read a first time in the House of Commons.

On the 2nd of March, the Bill was read a second time.

On the 21st of March, Mr. Counsellor Adam, on behalf of the Railway Company, made his opening speech in committee.

On the 2nd of May, Mr. Spankie summed up for the Railway; and on the 3rd, Mr. Counsellor Harrison led on the hostile van.

On the 30th of May, Mr. Harrison concluded the case for the opponents of the Bill.

On the 31st, Mr. Adam replied; after which the committee divided on the preamble, which was carried by a majority of one, 37 members being in favour of the Bill, and 36 against it.

On the 1st of June, the first clause of the Bill, empowering the Company to make the Railway, was lost, on a division, by a majority of 19 to 13. The clause to take land was then put to the vote, and also lost; whereupon

Mr. Adam, on behalf of the Railway Company, withdrew the Bill.

Such was the result of the first attempt in parliament to obtain the sanction of the legislature to the formation of the Liverpool and Manchester Railway. Scarcely, however, was the fate of the Bill decided for the passing session, before the first movement was made, and the first steps taken for a renewed effort in the succeeding year.

A deputation from the Railway Company assembled in London, in the first week in February, 1826.

On the 7th of February, the petition for the Bill was presented to the House of Commons by General Gascoyne.

On the 10th, the Bill was read a first time in the House of Commons.

On the 20th, it was read a second time.

On the 6th of April, the Bill was read a third time in the House of Commons. On the division, the numbers were, 88 in favour, 41 against—majority, 47.

On the 7th of April, the Bill was read a first time in the House of Lords.

On the 13th of April, Mr. Adam opened the case for the Railway in the committee of the Lords.

On the 27th of April, Mr. Harrison summed up for the opponents, and Mr. Adam replied; after which the committee adjourned till the 1st of May.

On that day, the committee of the Lords re-assembled, thirty-two peers being present. On a division, the preamble was declared to be proved, the numbers being 30 in favour, 2 against.

The bill was then read a third time in the Lords, and passed without a division.

Such is a brief outline of the parliamentary proceedings on the Liverpool and Manchester Railway Bill; a

measure which called into activity very powerful and conflicting interests.

The first general meeting of subscribers, under the authority of the act, was held in Liverpool on the 29th of May, 1826.

The most obvious mechanical advantage which a Railway possesses over a common turnpike road, is to be found in its superior hardness and smoothness of surface. This comparative advantage, it is evident, can be measured by no fixed standard, though it is common to estimate it in the proportion of seven to one. It should constantly be borne in mind, however, that this ratio of superiority in favour of a Railway can only exist on an exact level.

A level line being attained, it is scarcely of less importance that the Railway should be straight, or, at least, free from any abrupt curves. As the carriages are kept on the Rail by flanges on the wheels, it is obvious that where the curves are quick, the friction on the sides of the Rails, and consequent retardation, must be very great. This is a point which, till lately, has not been sufficiently attended to. In the Liverpool and Manchester Railway, the curves seldom exceed a deviation from a straight line of more than four inches in twenty-two yards, forming a segment of a circle, which, if extended, would embrace a circumference of fifteen miles. The setting out of the curves on the ground is a work requiring considerable skill and exactness, and the manner in which this is performed affects the real efficiency of the Railway no less than it does the style and beauty of its appearance.

The material of which the Rails were to be composed, whether of cast or forged iron, was a matter of some importance. Each description of Rail has its advocates; but, after due consideration and enquiry into their respective

merits, the Directors determined to adopt the forged or rolled-iron Rail, in lengths of five yards each, made after the Bedlington pattern, as described in Mr. Nicholas Wood's excellent book on Railways. A similar Rail is used on the Darlington way, but somewhat lighter; the Darlington Rail weighing 28 lbs., and the Liverpool and Manchester 35 lbs., per lineal yard. The Rails are supported every three feet, on stone blocks, each block containing nearly four cubic feet of stone. Two holes, six inches deep, and an inch diameter, are drilled in each block, and into these are driven oak plugs, and the cast-iron chairs or pedestals to which the Rail is immediately fitted and fastened, are firmly spiked down to the oak plugs, forming altogether a construction of great solidity and strength. On the embankments, where the foundation may be expected to subside, the Rails are laid on oak sleepers.

The consideration of the kind of power to be employed on the Railway, occupied no small portion of the directors' time and attention, whether Horses or Locomotive Engines—or fixed engines, drawing the load by means of ropes, from one station to another. Each of these modes had been tried, and each had its advocates, for in this case experience had by no means settled the point at issue.

The Directors resolved, on the 20th of April, 1829, to offer a premium of £500 for the most improved Locomotive Engine, subject to certain stipulations and conditions.*

Before concluding our account of the Railway, we shall take a single glance at the position we occupy, and the probable changes, whether for good or evil, which may be expected to occur (as the consequence of our

* For an account of these interesting experiments, see the Appendix.

operations) in the state and circumstances of the community around. The first and most obvious result must needs be a great revolution in the established modes of conveyance, both for merchandise and passengers, between Liverpool and Manchester, and consequently in the private interests of a large class of persons, who have been engaged directly or indirectly in the coaching or carrying business.

Already a Railway, on a grand scale, is advertised from London to Birmingham, and from Birmingham to Liverpool, and thus is commenced that grand trunk which will unite the North and the South, and bring into closer communication the capitals of England, Scotland, and Ireland.

But we must not confine our views to London, or Liverpool, or Manchester; there can be no question that foreign countries will adopt the Railway communication, as one great step in mechanical improvement and commercial enterprise. France, and Germany, and America, have already their Railways, and the Pasha of Egypt may be expected to follow close on the heels of his brother potentates. The country of the Pyramids, of Memphis, and of Thebes, shall then be celebrated for Railways and Steam Carriages; the land of the proud Mameluke, or the wandering Arab, of Sphynxes and Mummies, will become the theatre of mechanical invention, science, and the arts. The stately Turk, with his turban and slippers, will quit his couch and his carpet to mount his engine of fire and speed, that he may enjoy the delight of modern locomotion. So long is it since the reward was offered to the inventor of a new pleasure, that some scepticism were excusable as to the possibility of any great and novel excitement. But the Locomotive Engine and Railway were reserved for the present day. From West to

East, and from North to South, the mechanical principle, the philosophy of the 19th century, will spread and extend itself. The world has received a new impulse. To the fortunate few who are independent of times and circumstances, the present moment is a period of more than ordinary interest: to the world at large it continues, as it was wont to be, a season of labour and difficulty. The world and its inhabitants are constantly before us, and here we find no pause or resting place, no period of uninterrupted enjoyment or repose for the million. The genius of Watt, or Davy, or Stephenson, may improve the state of nations, or the fortunes of individuals, but it affects not the condition of the great mass of the human race; for this consummation we must look to other sciences than Chemistry and Mechanics,—to the tardy overthrow of prejudice, and the slow progress of unpopular truth, to the diffusion of that knowledge which teaches the laws and principles on which depend the moral, physical, and political condition, the subsistence and well-being of mankind.

General Abstract of Expenditure to 31*st May*, 1830.

				£.	*s.*	*d.*
Advertising Account	-	-		332	1	4
Brick-making Account	-	-		9724	4	4
Bridge Account -	-	-		99065	11	9
Charge for Direction	-	-		1911	0	0
Charge for Fencing -	-	-		10202	16	5
Cart Establishment	-	-		461	6	3
Chat Moss Account	-	-		27719	11	10
Cuttings and Embankments	-	-		199763	8	0
Carrying department, comprising Amount expended in Land and Buildings, for Stations and Depots, Warehouses, Offices, &c. at the Liverpool end -	£35538	0	0			
Expended at the Manchester Station -	6159	0	0			
Side Tunnel, being the approach to the Crown Street Station -	2485	0	0			
Gas Light Account, including cost of Pipes, Gasometer, &c. -	1046	0	0			
Engines, Coaches, Machines, &c. -	10991	11	4			
				56219	11	4
Carried forward				405399	11	3

	£.	s.	d.
Brought forward	405399	11	3
Formation of Road - - -	20568	15	5
Iron Rail Account - - -	67912	0	2
Interest Account (balance) - -	3629	16	7
Land Account - - -	95305	8	8
Office Establishment - -	4929	8	5
Parliamentary and Law Expenditure	28465	6	11
Stone Blocks, and Sleepers - -	20520	14	5
Surveying Account - - -	19829	8	7
Travelling Expenses - -	1423	1	5
Tunnel Account - - -	34791	4	9
Tunnel Compensation Account -	9977	5	7
Waggon Account - - -	24185	5	7
Sundry Payments for Timber, Iron, Petty disbursements, &c., not included in the foregoing Accounts - -	2227	17	3
	£739165	5	0

The total Expenditure, including Warehouses, Machinery, and Carriages, £820,000, which may be apportioned as follows:—			
Expenditure as above, in actual Payments, to 31st of May - - -	739165	5	0
Outstanding engagements to the same date - - - - -	7500	0	0
For Walling the Slopes in sundry Places, and completing Permanent Road -	6750	0	0
For completing the Bridges, including the Irwell £6000, and Parapets of the Sankey			
Carried forward	£753415	5	0

	£.	s.	d.
Brought forward	753415	5	0
Viaduct £1400, and compensation in lieu of Bridges - -	9500	0	0
Additional Engines, Waggons, and Machinery, part under contract for delivery	17000	0	0
Completing Stations, Wharfs, Warehouses, Offices, &c. - - -	25000	0	0
Fencing at sundry Places - -	3000	0	0
Contingencies - - -	12084	15	0
	£820,000	0	0

APPENDIX.—No. 1.

ACCOUNT

OF THE

COMPETITION OF LOCOMOTIVE ENGINES,

UPON THE

Liverpool and Manchester

RAILWAY.

(From the Liverpool Courier, Wednesday, Oct. 7, 1829.*)*

THE Directors of the Liverpool and Manchester Railroad having offered, in the month of April last, a prize of £500 for the best Locomotive Engine, the trial of the carriages which had been constructed to contend for the prize commenced yesterday. The running ground was on the Manchester side of the Rainhill Bridge, at a place called Kenrick's Cross, about ten miles from Liverpool. At this place the Railroad runs on a dead level, and formed, of course, a fine spot for trying the comparative speed of the carriages. The directors had made suitable preparations for this important as well as interesting experiment of the powers of Locomotive Carriages. For

the accommodation of the ladies who might visit the course, (to use the language of the turf,) a booth was erected on the south side of the Railroad, equi-distant from the extremities of the trial-ground. Here a band of music was stationed, and amused the company during the day by playing pleasing and favourite airs. The directors, each of whom wore a white ribbon in his button-hole, arrived on the course shortly aften ten o'clock in the forenoon, having come from Huyton in cars drawn by Mr. Stephenson's Locomotive Steam Carriage, which moved up the inclined plane from thence with considerable velocity. Meanwhile, ladies and gentlemen, in great numbers, arrived from Liverpool and Warrington, St. Helens and Manchester, as well as from the surrounding country, in vehicles of every description. Indeed, all the roads presented, on this occasion, scenes similar to those which roads leading to race-courses usually present during the days of sport. The pedestrians were extremely numerous, and crowded all the roads which conducted to the race-ground. The spectators lined both sides of the road, for the distance of a mile and a half; and although the men employed on the line, amounting to nearly 200, acted as special constables, with orders to keep the crowd off the course, all their efforts to carry their orders into effect were rendered nugatory, by the people persisting in walking on the ground. It is difficult to form an estimate of the number of individuals who had congregated to behold the experiment; but there could not, at a moderate calculation, be less than 10,000. Some gentlemen even went so far as to compute them at 15,000.

Never, perhaps, on any previous occasion, were so many scientific gentlemen and practical engineers collected together on one spot as there were on the Railroad

yesterday. The interesting and important nature of the experiments to be tried had drawn them from all parts of the kingdom, to be present at this contest of Locomotive Carriages, as well as to witness an exhibition whose results may alter the whole system of our existing internal communications, many and important as they are, substituting an agency whose ultimate effects can scarcely be anticipated; for although the extraordinary change in our river and coast navigation, by steam-boats, may afford some rule of comparison, still the effect of wind and waves, and a resisting medium, combine in vessels to present obstructions to the full exercise of the gigantic power which will act on a Railway unaffected by the seasons, and unlimited but by the demand for its application.

There were only one or two public-houses in the vicinity of the trial-ground. These were, of course, crowded with company as the day advanced, particularly the Railroad Tavern, which was literally crammed with company. The landlady had very prudently and providently reserved one room for the accommodation of the better class of visitors. The good lady will, we imagine, have substantial reasons for remembering the trial of Locomotive Carriages. But there is nothing like making hay while the sun shines.

The Locomotive Carriages which appeared on the ground were,—

No. 1.—Messrs. Braithwaite and Erickson, of London, "The Novelty;" weight, 3 tons, 15 cwt.

No. 2.—Mr. Hackworth, of Darlington, "The Sans Pareil;" weight, 4 tons, 8 cwt., 2 qrs.

No. 3.—Mr. Robert Stephenson, of Newcastle upon Tyne, "The Rocket;" weight, 4 tons, 3 cwt.

No. 4.—Mr. Brandreth, of Liverpool, "The Cyclopes;" weight, 3 tons; worked by two horses.

Mr. Burstall, of Edinburgh, did not bring his carriage out, in consequence of its having met with an accident on its road from Liverpool to the course. The damage will, however, be repaired, and the machine will, it is expected, be ready by to-morrow.

The Locomotive carriages attracted, of course, the attention of every individual on the ground. They ran up and down the road during the forenoon, more for amusement than experiment, surprising and even startling the unscientific beholders, by the amazing velocity with which they moved along the rails. Mr. Robert Stephenson's carriage attracted the most attention during the early part of the afternoon. It ran, without any weight being attached to it, at the rate of twenty-four miles in the hour, shooting past the spectators with amazing velocity, emitting very little smoke, but dropping red-hot cinders as it proceeded. Cars, containing stones, were then attached to it, weighing, together with its own weight, upwards of 17 tons, preparatory to the trial of its speed being made. The precise distance between the point of starting, at or near the weighing shed, to the point of returning, was 1¾ mile; but in the adjudication of distances, we are given to understand the judges allowed a furlong at each end for the acquirement and abatement of speed. The observations we record apply, however, to the whole distance. With a load of 12½ tons gross, the Rocket travelled the above space of 1¾ mile, four times forward and backward, equal to 14 miles, in the space of 75 minutes, exclusive of stoppages; but, including the stoppages, the average rate was 10½ miles per hour. But in the fifth course, the rate of speed, with a load augmented by

passengers until equal to 13 tons, was full 15 miles an hour.

Mr. Hackworth, of Darlington, ran his carriage along the course during the day; but no trial of its speed with weights took place yesterday.

Mr. Winan's machine, worked by two men, and carrying six passengers, was also on the ground. It moved with no great velocity, compared with the Locomotive Steam-carriages, but with considerable speed considering that it was put in motion by human power. One of its wheels was, we believe, slightly damaged in the course of the afternoon, by Mr. Hackworth's Locomotive Steam-carriage.

Mr. Brandreth's horse-power Locomotive Engine exhibited, not in the way of competition, but as exercise. About fifty persons clung round the waggons, giving a gross weight, with the machine, of about five tons, and with this weight, the horses (themselves moving scarcely one mile and a quarter an hour) propelled the waggons and load exactly at the rate of five miles an hour. This could scarcely be called a fair trial of the ingenious inventor's machine, nor was it as such considered by the judges; and on the supposition that before our next number this machine will be put in more effective motion, we will not make any comments on an exhibition which was not intended as a conclusive experiment.

The engine of Messrs. Braithwaite and Erickson, of London, was universally allowed to exhibit, in appearance and compactness, the beau-ideal of a Locomotive Engine. Its performance, whilst exercising without a load, was most astonishing, passing over a space of 2¾ miles in seven minutes and a quarter, including a stoppage. With this delay, its rate of speed was about 23

miles an hour. While running, the progress was upwards of 28 miles an hour. Owing to a variety of circumstances, this engine was prevented from being ready to start with a load until a late hour, when, at the request of the directors, its exhibition was postponed until this day. The velocity with which it moved surprised and astonished every beholder. It seemed, indeed, to fly, presenting one of the most sublime spectacles of human ingenuity and human daring the world ever beheld. It actually made one giddy to look at it, and filled thousands with lively fears for the safety of the individuals who were on it, and who seemed not to run along the earth, but to fly, as it were, on "the wings of the wind." It was a most sublime sight,—a sight, indeed, which the individuals who beheld it will not soon forget.

The roads were, of course, as much crowded at night by passengers and vehicles returning from the ground, as they had been in the morning by people and passengers crowding thither. Fortunately not the slightest accident took place to mar the pleasures of the day.

The contests will be resumed this forenoon. They are likely to continue on to-morrow and Friday, it being the desire, as well as the interest of all the parties concerned, to make the experiments as numerous and as complete as possible.

The number of engineers, and other scientific men, who have come to Liverpool on this occasion, is perhaps unprecedented. We have obtained an imperfect list of the names of these gentlemen, which our brother editors may probably augment in the course of the week.

Mr. Jardine, of Edinburgh; Mr. Rastrick, of Stourbridge; Mr. Wood, of Killingworth; Mr. Vignoles, of London; Mr. Bennett, of Manchester; Mr. Dagleish, of Bolton; Mr. Price, of Neath Abbey; Mr. Burstall, of

Edinburgh; Mr. Fairbairn, of Manchester; Mr. Storey, of Darlington; Mr. Hackworth, of Darlington; Mr. Sinclair, of Bolton; Mr. Braithwaite, of London; Mr. Gillespie, of Newton; Mr. Hartley, of Liverpool; Mr. Lilley, of Manchester; Mr. Stephenson, of Newcastle-upon-Tyne; Mr. Longridge, of Bedlington; Mr. Locke, of Liverpool; Mr. Dixon, of Eccles; Mr. Brandreth, of Liverpool.

From the Liverpool Times, Tuesday, October 13.

The trial of Locomotive Carriages, which we have noticed at considerable length in our columns, is likely not only to answer the object of the directors of the Railway, but to produce an important benefit to the useful arts. By calling the attention of the most ingenious and scientific men in the kingdom, to the production of a machine calculated for rapid motion on a Railway, by stimulating their emulation and self-interest, and by drawing them and their machines together to a public competition, it is more than probable that the progress of improvement in this branch of scientific invention has been accelerated several years. On this occasion, the advantages of competition are peculiarly conspicuous. It frequently happens that both inventors and the public suffer from the want of an opportunity of comparing separate inventions together, so as fairly to exhibit their respective merits. Each inventor flatters himself that his own machine is the best, and, partly from ignorance of what has been done by others, partly from a natural partiality for his own plans, he often perseveres for a long period of time, in a wrong path, and struggles with difficulties which the ingenuity or good fortune of others has already overcome. A public competition, therefore, is

useful in exposing to the machinist his own errors and defects, and in showing him the furthest point of improvement to which any one has yet advanced. One inventor may have excelled in one particular, and another in another; when they are brought together, and their inventions put to the test, each is made acquainted with the discoveries of all the rest, and thus a sudden spring is given to mechanical improvement. Nor is the advantage confined to inventors who may dare to compete, but all manufacturers of steam engines, or other engines analagous to them, have here an opportunity of seeing the greatest perfection to which the art has yet been carried, and may thus receive the most valuable instruction. A general knowledge of the mechanical arts is diffused, the wits of many embryo inventors are set on work, and the seeds are probably sown of still more admirable discoveries than have ever yet been seen.

The due reward of merit is the greatest stimulus to improvement; and, in the present case, the merit of the victorious competitor will no doubt be very richly rewarded, not only by the liberal premium which the directors offer, but by the reputation and consequent business which he will acquire, and perhaps also by an order for the construction of Locomotive Carriages for the Liverpool and Manchester Railway.

The immediate advantage to the public is also very great. The proprietors of every Railway in the kingdom may profit by the present competition. Several machines have now been exhibited, which far surpass, in their combination of power and velocity, any Locomotive Engine hitherto in use. Two of them have given the public quite a new idea of what may be accomplished in land conveyance. The writer of this article has often said in private, that he expected, in the course of some

years, to be able to travel from Liverpool to Manchester by the Railway, in an hour and a half; but he thought this a bold anticipation, and only looked for its fulfilment as the result of years of experiment and practice. The invention, at so early a period, of a machine which will probably accomplish the distance in a single hour, flying over the earth at the speed of a mile in two minutes, has outstripped his most sanguine hopes.

When the Liverpool and Manchester Railway is completed, and the Locomotive Carriages are plying upon it, we shall undoubtedly possess a mode of conveyance superior to any that the world has hitherto seen, and one which must be pronounced a noble monument of mechanical genius, and commercial enterprize. When compared with the public roads and conveyances in the middle of the last century, it shows a prodigious advance in art and science, greater even than the improvement made in lighting our streets and houses by gas, for which a clever writer in the "Westminster Review" claims a statue to the inventor. He truly observes, that the progress made in the useful arts in this country, within a short period, is almost inconceivable, and entitles those men, to whose genius and perseverance we owe it, to a praise far above that of warriors and conquerors. With every means of invention in art, and discovery in science, this country rises another step in civilization; and such are now the means of extending and perpetuating the knowledge of these inventions, that they may be considered as so much ground gained for the whole race of mankind, and as placing our species at a further remove from the possibility of relapsing into general barbarism.

On Tuesday last, the long-expected contest of Locomotive Carriages commenced at Rainhill, and during the whole of the week the different carriages were prac-

tising on the Railroad. The contest is not yet concluded, nor is it likely to be for some days; but the trials which have already been made have proved that several of the carriages are possessed of power and speed of the most surprising kind. Nothing has yet occurred to enable any one to judge, with certainty, of the comparative merits of the different carriages; but we have no doubt that they will all be found greatly to surpass every kind of Locomotive power that has ever before been used.

On Tuesday, the first day of trial, the race-ground presented a scene of extraordinary gaiety and bustle. The day being remarkably fine, thousands of persons of all ranks were assembled from the surrounding towns and districts. Upwards of 10,000 persons were computed to have been present, among whom were a greater number of scientific men, and practical engineers, than have been assembled on any previous occasion. The ground was extremely favourable for the spectators, and the performances of the different carriages were such as to excite the strongest feelings of admiration and surprise.

The gentlemen appointed by the directors to act as judges on the occasion, were, T. U. Rastrick, Esq., of Stourbridge, civil-engineer; Nicholas Wood, Esq., of Killingworth, civil-engineer, (author of the excellent work on Railways); and John Kennedy, Esq., of Manchester. These gentlemen will report the result of the experiments to the directors, who have reserved to themselves the power of awarding the prize of £500 to the carriage which they, in their judgment, may deem best entitled to it.

During the whole of the day the different carriages were exhibiting on the Railway, and it is scarcely possible for any one who has not seen them in motion to form any conception of their astonishing speed. In the

early part of the day, the carriage of Mr. Robert Stephenson, of Newcastle, attracted great attention. It ran, without any weight attached to it, at the rate of 24 miles in the hour, rushing past the spectators with amazing velocity. It has been stated by several of the papers that it emitted very little smoke; but the fact is, that during the trial it emitted none. Previous to the trial, a little coal was put into it, and then it sent forth a smoke; but after the trial had commenced, it used coke, which, as it does not produce any smoke, of course could not emit any. We know that there were some persons on the ground who mistook steam for smoke. After this carriage had moved about for some time, without any weight, cars, containing stones, were attached to it, weighing, together with its own weight, upwards of 17 tons, preparatory to the trial of its speed being made. The precise distance between the point of starting, at or near the weighing shed, to the point of returning, was 1¼ mile; but in the adjudication of distances, we are given to understand the judges allowed a furlong at each end for the acquirement and abatement of speed. Our observations apply, however, to the whole distance. With a load of 12½ tons gross, the Rocket travelled the above space of 1¼ mile, four times forward and backward, equal to 14 miles, in the space of 75 minutes, exclusive of stoppages; but, including the stoppages, the average rate was 10½ miles per hour. In the fifth course, the rate of speed, with a load augmented by passengers until equal to 13 tons, was full 15 miles an hour.

Mr. Hackworth, of Darlington, ran his carriage along the course during the day; but no trial of its speed with weights took place.

Mr. Winan's machine, worked by two men, and carrying six passengers, was also on the ground. It moved

with no great velocity compared to the Locomotive Steam-Carriages, but with considerable speed considering that it was put in motion by human power. One of its wheels was damaged in the course of the afternoon, by Mr. Hackworth's Locomotive Steam-Carriage.

Mr. Brandreth's horse-power Locomotive Engine exhibited, not in the way of competition, but as exercise. About fifty persons clung round the waggons, giving a gross weight, with the machine, of about 5 tons, and with this weight, the horses (themselves moving scarcely one mile and a quarter an hour) propelled the waggons and load exactly at the rate of five miles an hour.

The engine of Messrs. Braithwaite and Erickson, of London, was universally allowed to exhibit, in appearance and compactness, the beau-ideal of a Locomotive Carriage. Its performance, whilst exercising without a load, was most astonishing, passing over a space of $2\frac{3}{4}$ miles in seven minutes and a quarter, including a stoppage: it actually did one mile in the incredibly short space of one minute and thirty-three seconds! Had the Railway been completed, the engine would, at this rate, have gone nearly the whole way from Liverpool to Manchester within the hour. Mr. Braithwaite has, indeed, publicly offered to stake £1000, that as soon as the road is opened, he will perform the entire distance in that time. The velocity with which the Novelty moved, surprised and amazed every beholder. It seemed indeed to fly, presenting one of the most sublime spectacles of mechanical ingenuity and human daring the world ever beheld. It actually made one giddy to look at it, and filled the breasts of thousands with lively fears for the safety of the individuals who were on it, and who seemed not to run along the earth, but to fly, as it were, "on the wings of the wind."

We understand that one of the points in which this carriage differs from its competitors, is in having a pair of bellows constantly in action, the blast of which keeps the fire bright, and the steam up, while the machine is running. An attempt was made some time ago to introduce this principle into practice on a Locomotive Engine on the Bolton and Leigh Railway, but we believe that it entirely failed. Messrs. Braithwaite and Erickson, however, appear to have overcome the difficulty, and the principle has been applied to their carriage with signal advantage, so far as it is possible to judge from the experiments which have been already tried. The boiler of their engine is also on a new and peculiar construction, and is said to possess great advantages over those which are already in use. The Novelty also possesses the advantage of carrying within itself the fuel and water necessary for its operations. Mr. Burstall's engine does this also.

On Wednesday, the contest was resumed, but owing to the extremely unfavourable state of the weather in the morning, the attendance was far less numerous than on the preceding day. This was the day appointed for the trial of Messrs. Braithwaite and Erickson's beautiful carriage. It drew the weight assigned by the judges, namely, 6 tons 2 cwt., at the rate of $20\frac{3}{4}$ miles per hour. Unfortunately, however, the bellows burst after the first trip, so that the experiment had to be postponed till another day. The carriages of Messrs. Stephenson, Hackworth, and Brandreth were also on the course, and made several trips.

The first systematic trial of the power of the engines, under the inspection of the judges, took place on Thursday, when Mr. Stephenson's carriage, the Rocket, was brought out to perform the task assigned. This engine

has a boiler of a new construction, adapted for coke, the invention of Mr. Henry Booth, the treasurer to the Railway Company. The distance appointed to be run was 70 miles; and it was a condition that, when fairly started, the engine was to travel on the road at a speed of not less than 10 miles per hour, drawing after it a gross weight of 3 tons, for every ton weight of itself. Before starting, the machine was weighed, and the weight ascertained to be 4 tons 5 cwt.; the gross weight to be drawn, therefore, was 12 tons 15 cwt., which was accordingly placed behind the engine, part of the said weight consisting of the engine tender, with the needful supply of water and fuel. The prescribed distance of 70 miles, it must be remembered, was to be accomplished by moving backwards and forwards, on a level plane of one mile and three-quarters in length; of course the engine had to pass along this plane 40 times, having to make as many stops, and each time to regain the lost speed and momentum. She started on her journey about half-past ten in the morning, and performed the first 35 miles in 3 hours and 10 minutes, being upwards of 11 miles an hour. About a quarter of an hour was then consumed in filling the water tank, and obtaining a fresh supply of coke. The second 35 miles were accomplished in less time than the first, being performed in 2 hours and 52 minutes, which is at the rate of upwards of 12 miles an hour, including stoppages, the whole time from the first starting to the final arrival being under six hours and a half. The speed of the carriage over the ground was frequently 18 miles per hour, and sometimes more, and the motion is represented by the gentlemen who accompanied it, as particularly easy and agreeable. The engine having to return and stop at the same point so frequently, opportunity was thereby afforded for a considerable number of gentlemen

to have the pleasure of a ride; amongst others mounted behind the engine, we noticed Dr. Traill, Mr. Robert Gladstone, Mr. Henry Moss, &c. &c. On the whole, the performance gave great satisfaction, and the work done was far more than the quantum prescribed by the Directors of the Railway.

On Friday, the fourth day, nothing important or very interesting occurred on the course, but a paragraph appeared in Friday's paper, from Messrs. Braithwaite and Erickson, stating that their engine, the Novelty, would be ready to perform the appointed task on Saturday morning. Accordingly, great expectations were excited to witness this day's proceedings. The preliminaries of weighing, &c. being concluded, the Novelty, with her appointed load, started, and performed the first trip of three miles and a half in good style. On the second journey, however, owing to an accident to one of the pipes, all locomotion was suspended; and before the injury, though unimportant, could be repaired, the day was too far advanced to recommence her allotted task. It was evident, from the frequent, though slight, derangements which had occurred to this engine, that a little further time was desirable before her performance should be again brought under the special notice of the judges. Accordingly, it was arranged by mutual consent that the London engine should run the 70 miles with her load on Wednesday (tomorrow). On the Saturday afternoon, however, the injury sustained being repaired, she appeared again on the course, with the Directors' carriage attached to her, in which were about forty ladies and gentlemen, and with which she moved along in beautiful style at the almost incredible speed of upwards of 30 miles per hour! In the course of the day, Mr. Stephenson's engine also performed an equally brilliant feat. Between the occurrence

and the repair of the accident to Messrs. Braithwaite's carriage, that of Mr. Stephenson, the Rocket, ran, without load or tender, 7 miles in 14 minutes, which is at the rate of 30 miles an hour; and one of the trips of 3½ miles was performed in 6 minutes and 37 seconds, which is at the rate of 32 miles an hour!

FROM THE LIVERPOOL CHRONICLE.

Wednesday (Eighth Day).

We may consider the trial of the Locomotive Engines virtually at an end. In consequence of the number of petty accidents which had occurred to the London engine, "The Novelty," the ingenious inventors, Messrs. Braithwaite and Erickson, (rather unadvisedly, we consider,) took their engine to pieces after the performance of Saturday, and they only had the joints of the boiler pipe closed this morning. Every engineer knows the effect of a high pressure upon a green joint, but as the Novelty had been entered for this day's contest, the proprietors determined upon starting. Accordingly, at one o'clock, the engine was set off, and performed about 7 miles in a manner highly satisfactory, going at one time at the rate of 24 miles an hour, with its accustomed load, when the green joint of the boiler pipe gave way, as might have actually been expected, and the engine was obliged to stop. It is much to be regretted that the Novelty had not been built in time, to have the same opportunity of exercising that Mr. Stephenson's engine had, or that there is not in London, or its vicinity, any Railway where experiments with it could have been tried. It will evidently require several weeks to perfect the working of

the machine, and the proper fitting of the joints, and under this impression Messrs. Braithwaite and Erickson have acted wisely in withdrawing, as they have done, from the contest.

In the early part of the day, Mr. Stephenson's engine ascended the Rainhill inclined-plane several times, with heavy loads of passengers, and did this at a rate of 12 miles an hour; now, considering the rate of ascent is 1 in 96, or upwards of a third of an inch in a yard, we consider the erection of fixed engines on that and the other inclined-plane at Sutton as quite out of the question, and that before very long we may hear of Railways by the sides of our turnpike roads.

Mr. Burstall exercised his engine, but we believe we are correct in stating, this gentleman is conscious that his engine is not sufficiently powerful to compete with the other three. He will, however, continue to try its powers.

It is now understood that Mr. Hackworth's engine is overweight for the original conditions. We have, however, heard that Mr. H. disputes this point, and will try again.

Mr. Brandreth will also exhibit again; but as he can have, under the present circumstances, no chance of succeeding against what has been done, it is probable his appearance will not be as a competitor.

The course is thus left clear for Mr. Stephenson, and we congratulate him with much sincerity on the probability of his being about to receive the reward of £500.

FROM THE SCOTSMAN OF 14TH OCT., 1829.

"*Report to the Directors of the Liverpool and Manchester Railway, on the comparative Merits of Locomotive and Fixed Engines as a Moving Power.*"

We are indebted to a friend for a perusal of this report, which comprehends by far the most complete and well-digested body of information respecting Railway carriage that we have seen. We consider it extremely valuable, especially to civil-engineers; and as the experiments now making at Liverpool give a peculiar interest to the subject, we shall present our readers with some of Mr. Walker's general conclusions. Mr. Walker and Mr. Rastrick were employed in January last, jointly by the Railway Company, to report upon the matters indicated in the title. In pursuance of this object, they visited all the principal Railways in the north of England, made the most minute and careful enquiries as to the vehicles and species of moving power employed on them, and then gave the result of their investigations in separate reports. Mr. Rastrick's report we have not seen, but we understand it agrees in every essential circumstance with Mr. Walker's.

The trade from Liverpool to Manchester is estimated by the directors at 2,000 tons per day of goods, or 3,000 tons gross, that is, including the carriages which convey them. Mr. Walker was required to frame his report, with a reference to this amount of carriage.

The length of the Railway is 34 miles. It has two tracks, one for going, and another for returning, and three inclined planes, one in the tunnel at Liverpool $1\frac{1}{8}$ mile long, rising 1 foot in 48; one at Rainhill, 7 miles eastward, rising 1 foot in 96, and $1\frac{1}{2}$ mile long; and one at Sutton, of the same length and depth. The other parts of the line scarcely differ sensibly from a dead level, never rising more than 1 foot in 800.

Mr. Walker assumes the most convenient Locomotive Engine to have a power to 10 horses, wheels 5 feet diameter, steam at 40 or 50 lbs. per square inch, and to weigh, with its tender, (a carriage which follows it with coals and water), 10 tons. It will be observed, that the Rocket, the Novelty, and other engines now trying at Liverpool, have not one half of this weight. An engine of this description, he finds, can take $19\frac{1}{2}$ tons gross, or 13 tons of goods, and $6\frac{1}{2}$ of waggons, at 10 miles per hour, which is reduced to 9 by stoppages. It will cost, with its tender, £720. Its annual expense in working, he estimates at £56 for capital (assuming it to last 20 years), at £107 for annual repairs, and £204 for wages, coal, &c. The original cost of a Steam-horse, therefore, is £720, and the annual expense of working him £367.

This Locomotive Machine will make three trips daily between Liverpool and Manchester, with 13 tons of goods, which is equal to the conveyance of 1,170 tons one mile. Now, estimating the daily traffic at 4,000 tons, conveyed 30 miles, or 120,000 tons one mile, the work upon the Railway will require 102 engines, costing £37,000 of annual expense. But stationary engines are necessary at the inclined planes, and these increase the annual charge to £43,000. This may be considered as the entire annual expense upon the Locomotive system, and this divided, according to the quantity of goods

conveyed, gives an expense of ·2787 of a penny, or a little more than one farthing (1⅛ farthing precisely) per mile for each ton of goods. This is the mere expense for vehicles and traction, exclusive of Railway dues.

One-fifth more engines than are used require to be kept, to supply the place of those under repair. Adding these, the amount of capital necessary to furnish the Locomotive and Fixed Engines with their appendages upon this plan, will be £91,000. This is exclusive of the steam-power to be employed at the tunnel.

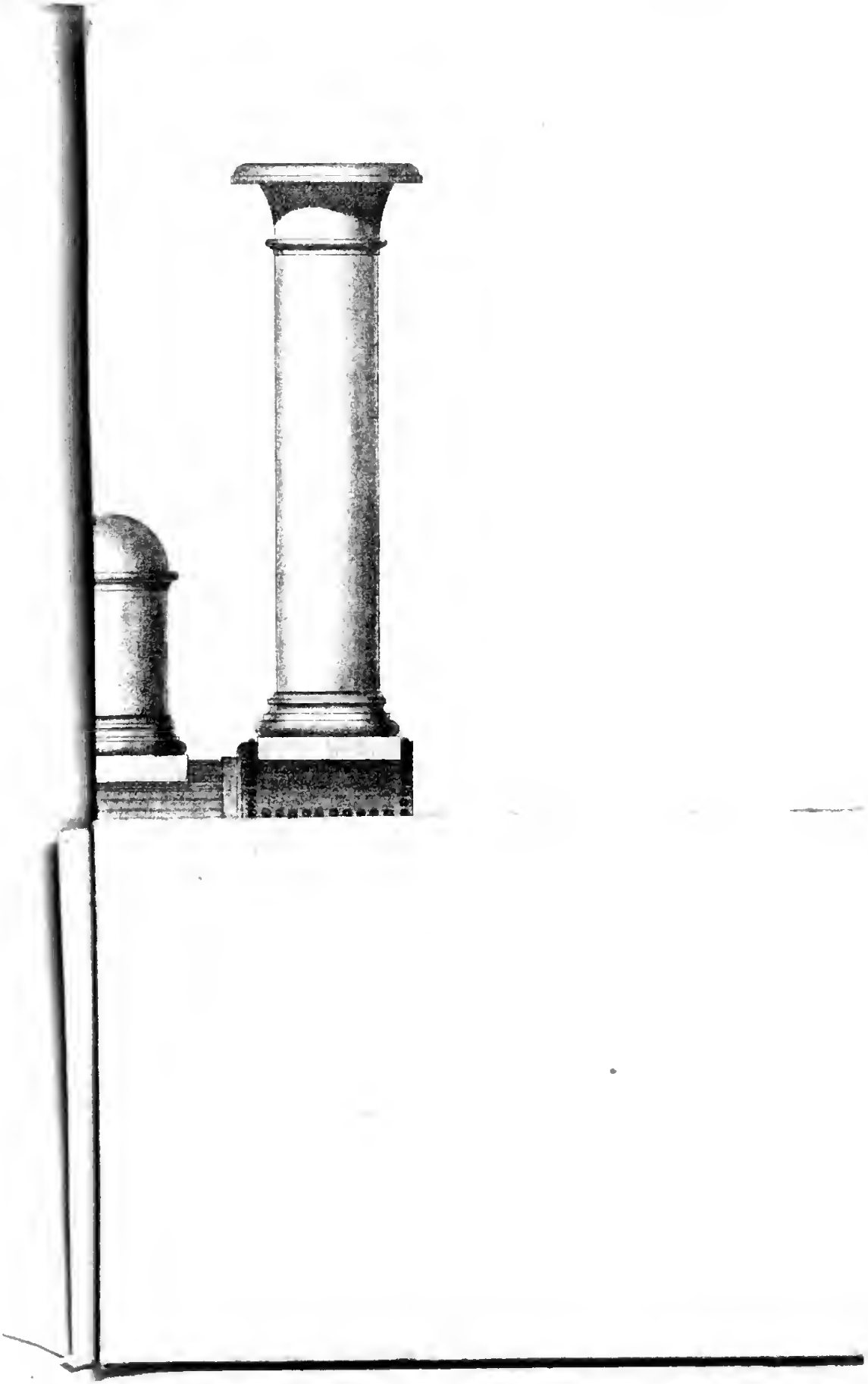
Mr. Walker next estimates the expense of the Stationary Engine system. Upon this system, the line is to be divided into stations of 1½ miles, and in some cases of 1 mile long, with two engines at each. It is assumed that the fixed engines are to drag the carriages at 12 miles an hour, which is reduced to 9 by stoppages. The whole line would, according to this plan, require 41 steam-engines, viz.:—two of 60-horse power, 15 of 30-horse power, and the others of 12 or 20. These engines would cost £87,000; but the other necessary articles being added, the entire capital required would be £101,000. The annual expense of working the fixed engines would be £33,000, and the sum divided by the number of tons conveyed makes the rate per mile, ·2134, or one one-fifth of a penny for each mile.

In a Report, printed two years ago, we find it stated, that the Company would be able to convey goods from Liverpool to Manchester, at 3 shillings or 4 shillings per ton; but let us call it 5 shillings. At present the charge varies from 12 shillings to 20 shillings, and may average about 15 shillings. Now it is estimated that about 2,000 tons pass each way daily; and as 10 shillings will be saved upon each ton, it follows that the saving upon 4,000 tons will amount to £2,000 per day, or the enormous sum

of £600,000 per annum! A saving, such as no single improvement ever before produced. And in this estimate we do not take into account the advantage derived from the unexampled speed of communication, which will give Liverpool and Manchester nearly all the facility of intercourse they could possess if they were parts of one city.

LOCOMOTIVE ENGINES.

The recent trial of these on the Liverpool and Manchester Railway, of which we have given a particular account, is without doubt one of the most interesting experiments, in regard to the powers of such machines, which has yet occurred, whether we view it as an exhibition of scientific and mechanical skill, or look forward to the wonderful improvements in the intercourse and internal communications of the country to which this grand discovery may yet be applied. In regard to the use of Locomotive Carriages upon common roads, we have repeatedly and decidedly expressed our opinion, and the reasons for it, that all such projects are crude and ill-considered, and inconsistent with any just view of principles; and we regret to see ingenious persons still wasting their efforts on such vain projects. But on Railways, as we formerly stated, all those impediments, by which the Engine is rendered so inefficient, even on the smoothest turnpikes, are entirely removed. There the Engine, however ponderous, meets with hardly any resistance to oppose its progress, and accordingly drags after it the most enormous loads; and when these are lessened or thrown off, it then advances with a speed beyond any thing ever attempted on land or water, and to which indeed we can hardly assign any limits, because the Engine is neither checked like animal force by the mere



speed of its motion, nor resisted as in navigation, by the continued and increasing opposition of the element in which it moves. It is on the Railway, therefore, that the powers of the Locomotive Engine have always been displayed with striking effect, and the Engines lately exhibited furnish new and remarkable examples. With a load of thirteen tons, including many passengers, Mr. Stephenson's Engine, the Rocket, travelled at the rate of fifteen miles an hour; and the Engine of Braithwaite and Erickson, of London, moved at the astonishing speed of twenty-eight miles an hour. "It seemed, indeed, (says a spectator), to fly, presenting one of the most sublime spectacles of human ingenuity and human daring the world ever beheld. It actually made one giddy to look at it, and filled thousands with lively fear for the safety of the individuals who were on it, and who seemed not to run along the earth, but to fly, as it were, on the wings of the wind. It was a most sublime sight—a sight, indeed, which the individuals who beheld it will not soon forget." Such is the account of those Engines, and we cannot conclude without remarking, how slowly improvements advance, even in our own enlightened community; and how much they are retarded by prejudice and by partial and interested views. The Locomotive Engine has now been travelling on Railways for upwards of twelve or fifteen years, and with complete success, yet the Liverpool and Manchester Railway Company were originally restricted by their act of parliament to the use of horses; and even after the self-moving Engines were allowed, a warm controversy arose on the question, whether it might not be advisable to substitute the artificial, and in other respects extremely inconvenient, apparatus of Fixed Engines, and long ropes extending from mile to mile all along the road—and lastly,

the first engineer of the day has recently declared himself, from want of experience, incapable of offering an opinion whether either of these plans will fully answer in practice. Nothing, however, can prevent, sooner or later, the application to the purposes of trade and intercourse, a machine of such prodigious powers of trackage and swiftness of locomotion as above described. Let us only consider for a moment the consequences of such an engine travelling from London to Edinburgh, at the rate of 15 or 20 miles an hour, and thus performing the journey in less than a single day and night;—of the practicability of such a scheme there can be little doubt, and all that is wanted are capital and skill to carry it into effect.

APPENDIX.—No. 2.

LIVERPOOL AND MANCHESTER RAILWAY.

REPORT.

Liverpool, 28th September, 1831.

THE Directors, at the general meeting held in this place exactly six months ago, laid before the Proprietors the result of the working of the Railway for 3½ months, up to the 31st December, 1830.

They have now to report the result of six months' operations from the 1st January to the 30th June last. During that period the Company's business, both in merchandize and passengers, has been gradually and steadily on the increase.

The tonnage of merchandise conveyed between Liverpool and Manchester, for the six months, amounts to	35865	tons.	
Between Liverpool and the Bolton Junction -	6827		
	42692		
Coals, principally from the Huyton Collieries, a distance of five miles from Liverpool - - -	2889		
Number of passengers booked at the Company's offices	188726		
The gross receipts on this traffic are as follows:—			
On Passengers - - - - -	£43,600	7	5
On Merchandise - - - - -	21,875	0	1
On Coal - - - - -	218	6	2
	£65,693	13	8
Amounting to 4s. 7¼d. each, per passenger booked, and 10s. 3d. per ton of merchandise conveyed.			
The disbursements upon the same traffic amount to	£35,379	3	10
Or, belonging to the coaching department -	19,099	16	5
To merchandise, &c. - - - -	16,279	7	5
	£35,379	3	10

These disbursements, the Directors, from the classification of their accounts, are enabled to apportion to the different departments, and under different heads of expenditure, as follows:—

	Per Passenger booked.		*Per Ton of Merchandise.*		*Coaching Department*			*Merchandise Department.*			*Totals.*		
	s.	*d.*	*s.*	*d.*	*£.*	*s.*	*d.*	*£.*	*s.*	*d.*	*£.*	*s.*	*d.*
Disbursements exclusively in the Coaching Department, consisting of Porterege, Salaries, Repairs, &c., including 2½d. per Passenger for Omnibusses	0	7¾	...	...	6146	11	0	...	...	...	6146	11	0
Disbursements exclusively in the Merchandise Department, consisting of Porterage, Salaries, Cartages, &c.	...	...	3	10¾	...	...	...	8306	3	11	8306	3	11
Locomotive Power Account, proportioned according to the Number of Trips of 30 Miles, in each Department respectively, comprising Repairs of Engines, Wages, Coke, &c., including £88 17s. 3d. for Conveyance of Coal as Back-carriage	0	5¾	1	8¾	4505	18	10	3692	14	5	8198	13	3
Sundry Disbursements, proportioned according to the *Receipts* in each Department, consisting of Police Establishment, General Office Establishment, Maintenance of Way, Rates, Taxes, &c., including £2910 0s. 3d. for Interest of Money borrowed	0	10¾	1	11½	8447	6	7	4280	9	1	12727	15	8
Total Disbursements	2	0¼	7	7	19099	16	5	16279	7	5	35379	3	10
Amount of Profit	2	7	2	8	24500	11	0	5813	18	10	30314	9	10
Gross Receipts as per above Statement	4	7¼	10	3	43600	7	5	22093	6	3	65693	13	8

The Directors are happy to be able to state, that *although nearly half a million of passengers have been carried, only one fatal accident has occurred*, and that arose solely from the perverseness of the individual sufferer.

APPENDIX.—No. 3.

EXTRACT FROM A REPORT

OF THE

Committee of Management

OF THE

MONKLAND AND KIRKINTILLOCH RAILWAY COMPANY,

To the General Meeting of Proprietors, to be held on Wednesday, the 1*st Day of February*, 1832.

The Committee have, as mentioned in last year's Report, built two Locomotive Engines, which have now been in employment on the Railway for nearly six months; and the whole of the trade from the Collieries to Kirkintilloch, is now drawn by these Machines.

The Committee expect, by the use of the Engines in question, considerably to reduce the charges to Kirkintilloch, and have already allowed a reduction in the draggage charge to that place, as compared with the former charge of dragging by horses. Hitherto the sums received for the work performed by the Locomotive Engines have fully compensated the wear, tear, and expenses, and have afforded a sum to be laid aside for

replacement. In two particulars the introduction of draggage by Engines will be attended with very great advantage. The charges to the great and small trader will be equalized—a branch of their business, which required a great deal of superintendence, will be saved to them, and the expenses of maintaining the horsepath will be saved to the Company. The Company will moreover be enabled to give to their traders, and persons wishing to pass between the neighbourhoods of Airdrie and Kirkintilloch, a regular opportunity every two or three hours.

THE END.

NEWCASTLE : PRINTED BY J. BLACKWELL AND CO.

EXPERIMENTS ON THE COMPARATIVE STRENGTH OF DIFFERENT MALLEABLE IRON RAILS, Oct. 10, 1832.

Fish-bellied Rail, length 15 ft. 9¾ in., weight 262 lb., equal to 49·3 lb. ℔ yard.

Weights applied Midway between Bearings, in Cwts.	Bearings 3 ft. 0 15-16 in. apart.		Bearings 6 ft. 0⅛ in. apart.		Bearings 3 ft. 9 3 16 in. apart.	
	Deflexion 20 in. from one Bearing, and 16 15-16 in from the other.	Deflexion 11 in. from one Bearing, and 25 15-16 in. from the other.	Deflexion 34¼ in. from one Bearing, and 38 4-8 in. from the other.	Deflexion 29⅛ in. from one Bearing, and 43⅛ in. from the other.	Deflexion 21 1-16 in. from one Bearing, and 24⅛ in. from the other.	Deflexion 15⅛ in. from one Bearing, & 30 1-16 in. from the other.
20	–2	–2	17	17	5	4
34	4	4	43	38	9	8
48	6	5	63	60	15	14
62	9	8	89	81	21	19
76	12	11	112	94	29	25
90	16	14	121	110	35	31
104	19	16	156	144	42	36
118	22	19	permanent deflexion	permanent deflexion	48	41
132	25	21	12	12	56	46
146	28	23			63	54
160	32	27			69	61
174	35	29			76	63
188	37	30			permanent deflexion	permanent deflexion
202	41	33			3	3
216	44	35				
230	48	36				
	No permanent deflexion.					

Parallel Rail, length 15 ft. 10½ in., weight 256 lb., equal to 48·47 lb. ℔ yard.

Weights applied Midway between Bearings, in Cwts.	Bearings 3 ft. 0 15-16 in. apart.		Bearings 6 ft. 0⅛ in. apart.		Bearings 3 ft 9 3-16 in. apart.	
	Deflexion 20 in. from one Bearing, and 16 15-16 in. from the other.	Deflexion 11 in from one Bearing, and 25 15-16 in. from the other.	Deflexion 34⅛ in. from one Bearing, and 38 4-8 in. from the other.	Deflexion 29⅛ in. from one Bearing, and 43⅛ in. from the other	Deflexion 21 1-16 in. from one Bearing, and 24⅛ in. from the other.	Deflexion 15⅛ in. from one Bearing, & 30 1-16 in. from the other.
20	3	3	14	14	8	6
34	8	6	40	37	16	14
48	13	10	69	67	24	21
62	18	12	84	79	32	28
76	23	16	110	104	41	32
90	28	20	138	131	48	39
104	34	23	161	153	55	45
118	38	26	permanent deflexion	permanent deflexion	60	50
132	43	30	4	3	69	58
146	47	34			78	65
160	50	40			87	72
174	55	41			97	80
	permanent deflexion	permanent deflexion			permanent deflexion	permanent deflexion
	3	2			9	8

Fish-bellied Rail, eq. to 40·6 lb ℔ yard.

Weights applied Midway between Bearings, in Cwts.	Bearings 3 ft. 0¼ in. apart.	
	Deflexion 20 in from one Bearing, & 16¼ in. from the other.	Deflexion 11 in. from one Bearing, & 25¼ in. from the other.
20	4	3
34	8	7
48	14	11
62	20	17
76	26	23
90	31	28
104	37	31
118	44	38
132	51	44
146	58	50
160	66	55
174	72	61
	permanent deflexion	permanent deflexion
	6	4

Deflexion measured in 1088th parts of an inch.

London

To

Messrs. Longridge, Starbuck & Co

Gentlemen

I send
mittee with the Copies of the Reports to whic
satisfaction of the Directors at the favorable
the strength of the Rails tested under Profess
you would send for the same purpose two of
earliest conveyance, without waiting for a

London

Extract from the Minutes of the London Commi
Minute
1.222 Ordered,

That the Secretary be instru
Barlow's Reports of the 29th & 31st Oct. to M
sired to request them to state, if there is any
of their Rails as compared with others which can
of Professor Barlow, & that they will inform
manufactured from which their Rails were m
whether the Mine was [illegible]

n & Birmingham Railway
Office 83 Cornhill
18th Nov. 1836.

London.

ing you the enclosed Minute of the Com-
h it refers I am desired to express the
tatement which they have received of
r Barlows direction; and their wish that
your Rails, of 75 lbs to the Yard, by the
Shipment.

I am, Sir,

Your Obt. Servant
Signed R Creed.

don & Birmingham Railway
tee of the 16th Nov. 1836.

ted to forward Copies of Professor
efs. Longridge & Co and that he be de-
circumstance in the Manufacture
enable the Committee to solve the doubts
the Committee where the Pig Iron was
ade, whether hot or cold Blast, and